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WEST HILL POND DAM (V.. (U) CORPS OF ENGINEERS WALTHAM
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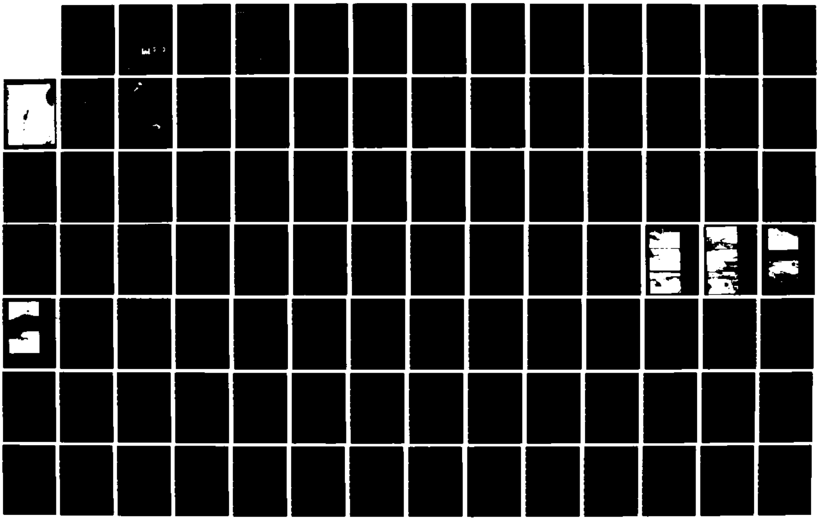

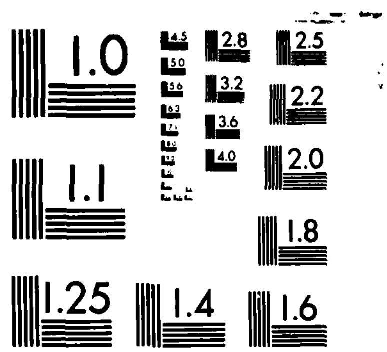

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

WINOOSKI RIVER BASIN
CABOT, VERMONT

WEST HILL POND DAM
VT 00083

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

JUNE 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
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18. SUPPLEMENTARY NOTES

Cover program reads: Phase I Inspection Report, National Dam Inspection Program; however, the official title of the program is: National Program for Inspection of Non-Federal Dams; use cover date for date of report.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

DAMS, INSPECTION, DAM SAFETY,

Winooski River Basin
Cabot, VT.
Branch of Jug Brook

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

The dam is 202 ft. long and 11.1 ft. high. It is small in size with a significant hazard potential. The dam was found to be in fair condition. There are three areas that warrent further investigation. There are various recommendations which should be implemented by the owner.

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION. CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM. MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED

JAN 06 1981

Honorable Richard A. Snelling
Governor of the State of Vermont
State Capitol
Montpelier, Vermont 05602

Dear Governor Snelling:

Inclosed is a copy of the West Hill Pond Dam (VT-00083) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. This report is presented for your use and is based upon a visual inspection, a review of the past performance and a brief hydrological study of the dam. A brief assessment is included at the beginning of the report. I have approved the report and support the findings and recommendations described in Section 7 and ask that you keep me informed of the actions taken to implement them. This follow-up action is a vitally important part of this program.

A copy of this report has been forwarded to the Department of Water Resources, the cooperating agency for the State of Vermont. In addition, a copy of the report has also been furnished the owner, Mr. Daniel Davis, Cabot, VT.

Copies of this report will be made available to the public, upon request, by this office under the Freedom of Information Act. In the case of this report the release date will be thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Water Resources for your cooperation in carrying out this program.

Sincerely,

WILLIAM E. HODGSON, JR.
Colonel, Corps of Engineers
Acting Division Engineer

Incl
As stated

DISCLAIMER NOTICE

WEST HILL POND DAM

VT 00083

WINOOSKI RIVER BASIN
CABOT, VERMONT

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.:	Vt. 00083
Name of Dam:	West Hill Pond Dam
Town:	Cabot
County and State:	Washington County, Vermont
Stream:	Branch of Jug Brook
Date of Inspection:	April 9, 1980

BRIEF ASSESSMENT

The West Hill Pond Dam is located on the southerly end of West Hill Pond on the easterly branch of Jug Brook, a tributary of the Winooski River. The dam is located approximately 1.8 miles from the Village of Lower Cabot. The dam was constructed to store water for use as flow augmentation to the Winooski River during low Winooski River flows; there is a lumber mill on the Winooski River in the Village of Lower Cabot utilizing the River for powering machinery in the mill. The dam is constructed of vertical upstream and downstream stone rubble walls laid without mortar with earth fill between the walls. The structure has a stone center spillway and a low level pond outlet located to the left of the spillway. The dam is 202 feet long and 11.1 feet high. The spillway is 11 feet long.

The West Hill Pond drainage area is approximately 1.9 square miles and is comprised of both open and forested land which rises up to steep hills. The dam impounds approximately 113 acre feet at spillway crest elevation 1135 feet NGVD and approximately 170 acre-feet at the top of the dam elevation 1136.2 feet NGVD. The dam is SMALL in size and its hazard classification is SIGNIFICANT.

The test flood for this dam is one half (1/2) the Probable Maximum Flood (PMF). The drainage area is 1.9 square miles and the test flood inflow (½ PMF) is 2450 CFS. Routing the test flood through the reservoir, with the initial pool level at the spillway crest elevation (1135 ft. NGVD), results in a test flood outflow of 1960 CFS from the dam at a pond stage of 1138.5 feet NGVD. The spillway and pond drain have a combined capacity with the water level at the top of the dam of 127 CFS, which is 6.5% of the test flood outflow. The dam will be overtopped by approximately 2.3 feet by the routed test flood.

Failure of the dam would pose a threat to one house, three unimproved road culverts, and the lumber mill dam on the Winooski River.

The dam was found in FAIR condition. There is a leak in the downstream face of the dam adjacent to the low level pond outlet, trees are growing on the dam, and rocks from the spillway channel wall and other debris have fallen into the downstream channel.

There are three areas that warrant further investigation. The leak in the dam face at the low level outlet, the adequacy of spillway capacity and the adequacy of low level outlet sluice gate.

The recommendations for additional investigations and remedial measures as listed in Section 7 should be implemented within one year of receipt of this report by the Owner.

COMMONWEALTH OF MASSACHUSETTS
JOHN W.
POWERS
No. 23106
REGISTERED
PROFESSIONAL ENGINEER
SANITARY

John W. Powers
Sanitary

John W. Powers
Massachusetts Registration 23106

This Phase I Inspection Report on West Hill Pond Dam has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

ARAMAST MAHTESIAN, MEMBER
Geotechnical Engineering Branch
Engineering Division

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

RICHARD DIBUONO, CHAIRMAN
Water Control Branch
Engineering Division

APPROVAL RECOMMENDED:

JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended guidelines for Safety Inspection of Dams for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, subsurface investigations, testing, and detailed computational evaluatons are beyond the scope of a Phase I investigation: however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition, and the downstream damage potential.

The Phase I Investigation does <u>not</u> include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

APPENDICES

(c) Appurtenant Structures

1. Low Level Pond Outlet Conduit (See photo 2)

There is one low level pond outlet conduit. The conduit walls and floor appear to be constructed in the same manner as the dam using stone rubble. The roof of the conduit appears to consist of flat granite slabs. Observations of the conduit could only be made from the downstream end of the conduit. It appears to be in good condition; there appeared to be no stone alignment problem or blockage of the conduit.

2. Low Level Pond Outlet Sluice Gate (see photo 6)

The low level pond outlet sluice gate appears to be constructed of wood plank. The gate could only be viewed through the water. There is no gate lifting mechanism other than a 4 in. x 4 in. wooden stem attached to the gate and projecting above the water approximately four feet. The gate appears to be raised by attaching either a rope or chain to the wooden stem and lifting the stem with a tractor equipped with a hydraulic loader or other similar equipment. The gate is closed by hammering down the wooden stem as evidenced by the relatively recent splitting of the top of the wooden stem from hammering. The water flow through the low level pond outlet conduit, indicates that the sluice gate does not completely seal off the flow of water.

(d) Reservoir Area (see photo 5 and overview photo)

The shore of the reservoir is primarily open land with some forested areas on the northerly (far end from dam) side. It appears to be stable and in good condition. There is no debris on the upstream side of the dam although there are some fallen trees and logs along the shore approaching the dam.

(e) Downstream Channel (see photo 1 and overview photo)

The downstream channel is approximately 9 feet wide with stone retaining walls on each side leading to an 8 foot diameter culvert at the road below the dam.

The stone retaining wall on the left side of the channel appears to be in good condition. The wall on the right side of the channel, however, has fallen in, partially obstructing the channel. The embankment above the right channel wall has washed down and covers much of the remaining portions of the wall.

3.2 Evaluation

The dam is generally in FAIR condition with the following deficiencies noted:

SECTION 3 - VISUAL INSPECTION

3.1 Findings

(a) General

The West Hill Pond Dam, No. VT 00083, was in FAIR condition at the time of the inspection.

(b) Dam

1. Embankment (See photos 3, 4, & 9)

The stone face of the dam appears to be generally in good condition except for some stones dislodged on the left downstream side; these stones appear to have been uplifted and heaved either from freezing or tree growth. Several small trees and brush are growing on the dam and in the dam rock wall. These do not appear to have caused any damage thus far to the dam.

Although the alignment of the dam is irregular there does not appear to be any movement of the dam. Most likely the dam was constructed in this manner.

There is a small leak which is estimated to be about 10 GPM of clear water to the right of the low level sluiceway. The cause of this leak could not be determined.

2. Spillway (see photos 7 & 8)

The spillway is grossly undersized as evidenced by the considerable quantity of trees and other debris located all along the downstream toe area of the dam, particularly at the left side of the spillway channel. It appears that the dam is overtopped frequently.

The floor of the spillway was apparently constructed using flat sided field stone with the interstices filled with soil. Some of the stones and soil on the upstream side of the spillway have either been removed or eroded away leaving a drop of about six inches between the concrete header on the upstream face and the adjacent spillway floor.

There appears to be no movement or erosion around the granite slabs of the spillway floor on the downstream end of the spillway.

SECTION 2 - ENGINEERING DATA

2.1 Design Data

Design data for West Hill Pond Dam is not available. There are no plans for West Hill Pond Dam available.

2.2 Construction Data

Construction data is not available for West Hill Pond Dam. The "Vermont Historical Gazetteer" Vol. IV, page 88 lists Avery Atkins as the builder of the dam and indicates that the dam was constructed in 1820.

2.3 Operation Data

There is no operational data available for West Hill Pond Dam.

2.4 Evaluation of Data

a) Availability

As stated previously there are no known design records such as plans, computations, etc., and the designer of the dam is not known. Such data, therefore, is not available.

b) Adequacy

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past-performance history and sound engineering judgment.

c) Validity

There is no design data for which validity can be assessed.

3. Description - The only regulated outlet from the dam is manually adjusted by hammering down a wooden wedge like stem attached to the gate for gate closing. To open the gate, a chain is attached to this same wooden stem and a mobile machine capable of a lifting force must be used to hoist the gate.

   The gate is only operated when increased flow from Jug Brook is required because flow in the Winooski River is not sufficient to operate the lumber mill in the Village of Lower Cabot. The frequency of gate operation is unknown.

(f) Reservoir Surface (acres)

1. Normal pool - 45±

2. Flood control pool - not applicable

3. Spillway crest - 45±

4. Test flood pool - 57±

5. Top of dam - 49±

(g) Dam

1. Type - Stonewall earth dam

2. Length - 202± feet

3. Height - 11.1±feet

4. Top Width - 18± feet

5. Side Slopes - Vertical

6. Zoning - Type of material unknown

7. Impervious Core - Unknown

8. Cutoff - Unknown

9. Grout Curtain - None

(i) Spillway

1. Type: - center spillway, broad crested weir

2. Length: - 11 feet

3. Crest Elevation: - 1135.0±

4. Gates - none

5. Upstream Channel: - Reservoir

6. Downstream Channel - Discharge to stone rubble impact basin then to discharge channel, rock walled 9± feet wide x 3± feet deep.

(j) Regulating Outlets

1. Invert - 1125.1±

2. Size - 36" wide, 28" high, conduit 18'± long

8) Total Project Discharge at Top of Dam elevation 1136.2 feet NGVD is 38 cfs.

9) Total Project Discharge at Test Flood Elevation of 1138.5 feet NGVD is 1961 cfs, and is comprised as follows:

a)	spillway discharge	189	CFS
b)	flow over dam	1771	CFS
	Total	1960	CFS

(c) Elevation (ft. NGVD)

1. Streambed at toe of dam - 1124.6±

2. Bottom of cutoff - unknown

3. Maximum tailwater - unknown

4. Normal pool - 1135.0±

5. Full flood control pool - not applicable

6. Spillway crest (ungated) - 1135.0±

7. Design surcharge - unknown

8. Top of dam - 1136.2±

9. Test flood design surcharge 1138.5 (dam overtopped by 2.3 feet)

(d) Reservoir (length in feet)

1. Normal pool - 3000±

2. Flood control pool - not applicable

3. Spillway crest pool - 3000±

4. Test flood pool - 4200±

(e) Storage (acre-feet)

1. Normal pool - 113±

2. Flood control pool - not applicable

3. Spillway crest pool - 113±

4. Top of dam - 170±

8) <u>Total Project Discharge at Top of Dam</u> elevation 1136.2 feet NGVD is 38 cfs.

9) <u>Total Project Discharge at Test Flood Elevation</u> of 1138.5 feet NGVD is 1960 cfs, and is comprised as follows:

a) spillway discharge		189 CFS
b) flow over dam		1771 CFS
	Total	1960 CFS

(c) <u>Elevation</u> (ft. NGVD)

1. Streambed at toe of dam - 1124.6±
2. Bottom of cutoff - unknown
3. Maximum tailwater - unknown
4. Normal pool - 1135.0±
5. Full flood control pool - not applicable
6. Spillway crest (ungated) - 1135.0±
7. Design surcharge - unknown
8. Top of dam - 1136.2±
9. Test flood design surcharge 1138.5 (dam overtopped by 2.3 feet)

(d) <u>Reservoir</u> (length in feet)

1. Normal pool - 3000±
2. Flood control pool - not applicable
3. Spillway crest pool - 3000±
4. Test flood pool - 4200±

(e) <u>Storage</u> (acre-feet)

1. Normal pool - 113±
2. Flood control pool - not applicable
3. Spillway crest pool - 113±
4. Top of dam - 170±

(i) Normal Operating Procedures

Water releases from West Hill Pond are varied as seasonal demand dictates.

1.3 Pertinent Data

(a) Drainage Area

The drainage area for the West Hill Pond Dam covers approximately 1.9 square miles. The drainage area and surrounding perimeter area rise to steep hills with both forested and open farming areas. There have been some dwellings built on the shore of the pond and there are farmsteads within the area.

(b) Discharge at Dam Site

Normal discharge at the site is via a 3' x 2.3' opening near the base of the dam at elevation 1125.1± (NGVD). This discharge is to a rock wall lined channel beginning at the downstream face of the dam. Flows greater than the sluiceway capacity discharge over the spillway at elevation 1135.0± (NGVD). It has been assumed that the normal pool elevation is at the crest of the spillway at elevation 1135.0± (NGVD). The U.S.G.S. map shows the water at 1135.0 (NGVD) and we have related all dam features to this datum. There are no existing plans for this dam. With the water level at the top of the dam, the sluiceway has a capacity of about 87 CFS.

1) Outlet Works conduit is 3 feet wide and 2.3 feet high, invert elevation 1125.1 feet NGVD and discharge capacity is 87 cfs.

2) Maximum Known Flood at Dam Site There is no data available for the maximum flood at the dam site.

3) Ungated Spillway Capacity at Top of Dam is approximately 38 cfs at elevation 1136.2 (feet NGVD).

4) Ungated Spillway Capacity at Test Flood Elevation With the water level at the test flood elevation of 1138.5 feet NGVD, the ungated spillway capacity is 189 CFS. The dam is overtopped by 2.3 feet.

5) Gated Spillway Capacity at Normal Pool Elevation None

6) Gated Spillway Capacity at Test Flood Elevation None

7) Total Spillway Capacity at Test Flood Elevation is approximately 189 cfs at elevation 1138.5 (feet NGVD). Dam overtopped by 2.3 ft.

3) Pond Level Control Sluiceway

The pond level control sluiceway is located in the center of the outlet channel, approximately 6 inches above the channel floor. A wooden sluice gate is located on the upstream dam face. The gate is lowered by hammering down a 4" x 4" wooden stem attached to the gate. There is no gearing or installed mechanical means of lifting the gate; a chain attached to the wooden stem and to a vehicle wrecker or a tractor equipped with loader bucket or backhoe appears to be the method used at present to lift the gate.

(c) Size Classification

The dam's maximum impoundment (computed to the top of the dam) of approximately 170 acre feet and height of 11.1 feet place it in the SMALL size category according to the Corps of Engineer's Recommended Guidelines.

(d) Hazard Classification

The hazard potential classification for this dam is SIGNIFICANT because of the economic losses and potential loss of life downstream which may occur in the event of dam failure. There is a potential for severely damaging one (1) home about one mile downstream of the dam with the possible loss of no more than a few lives as well as the loss of four (4) culverts at road crossings downstream of the dam.

(e) Ownership

The West Hill Pond Dam is owned by Mr. Daniel Davis. Mr. Davis' address is Cabot, VT, 05647.

(f) Operator

The West Hill Pond Dam is operated by the owner, Mr. Daniel Davis.

(g) Purpose of the Dam

The purpose of the dam is to provide a water supply for Jug Brook flow augmentation to the Winooski River for water power purposes during low Winooski River water flows. The owner of this dam owns and operates a hydromechanical powered lumber mill on the Winooski River in the Village of Lower Cabot.

(h) Design and Construction History

There are no records available describing either the design or construction of West Hill Pond Dam. As reported in the "Vermont Historical Gazetteer" Vol. IV, page 88, the dam was constructed in 1820.

1.2 Description of Project

(a) Location

The West Hill Pond Dam is located in the Town of Cabot, Vermont on the easterly branch of Jug Brook about 1.8 miles from the confluence of the Winooski River and Jug Brook. The dam is located on the southerly end of West Hill Pond. It can be reached by traveling northerly from the Village of Lower Cabot, on Town Road No. 3, West Hill Road, an unimproved road.

The dam is located on U.S.G.S. Plainfield, VT quadrangle at latitude N 44°-24'-54" and longitude W 72°-20'-48". Refer to the location plans for additional information.

(b) Description of Dam and Appurtenances

The dam consists of upstream and downstream vertical rock walls laid without mortar with earthfill between the two walls. The total length of the dam is approximately 202 feet including a 11 foot long spillway crest. The structural height of the dam is 11.1 feet. There are no construction drawings available.

1) Embankment

Sediment has filled in much of the upstream dam face. Downstream earthfill has been placed sloping down across the face from the abutments to the spillway channel. Each abutment end of the dam is constructed into natural, turf covered, earth slopes.

The top of the dam is covered with turf, small trees, and brush.

2) Principal Spillway

The principal spillway consists of a concrete header spanning the full upstream face of the spillway, the floor being stone rubble. The spillway is a flat broad crested weir approximately 1.2 feet below the top of the dam, 15 feet long on the upstream side of the dam, and 11 feet long on the downstream side of the dam. Resting on the concrete header and forming the walls of the spillway are three granite blocks on each side. The principal spillway is located approximately 133 feet from the right abutment and 5 feet to the right of the discharge channel. (See Appendix B - Plan of Dam Site and Spillway Details.)

The spillway impact basin consists of a stone rubble floor sloped towards the discharge channel.

NATIONAL DAM INSPECTION PROGRAM

PHASE I INSPECTION REPORT

WEST HILL POND DAM

NO. VT 00083

SECTION 1

PROJECT INFORMATION

1.1 General

(a) Authority

Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a National Program of Dam Inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Tighe & Bond/SCI has been retained by the New England Division to inspect and report on selected dams in Massachusetts. Authcrization and notice to proceed were issued to Tighe & Bond/SCI under a letter of October 24, 1979 from Colonel William E. Hodgson, Jr., Corps of Engineers. Contract No. DACW-33-80-C-0005 has been assigned by the Corps of Engineers for this work.

(b) Purpose

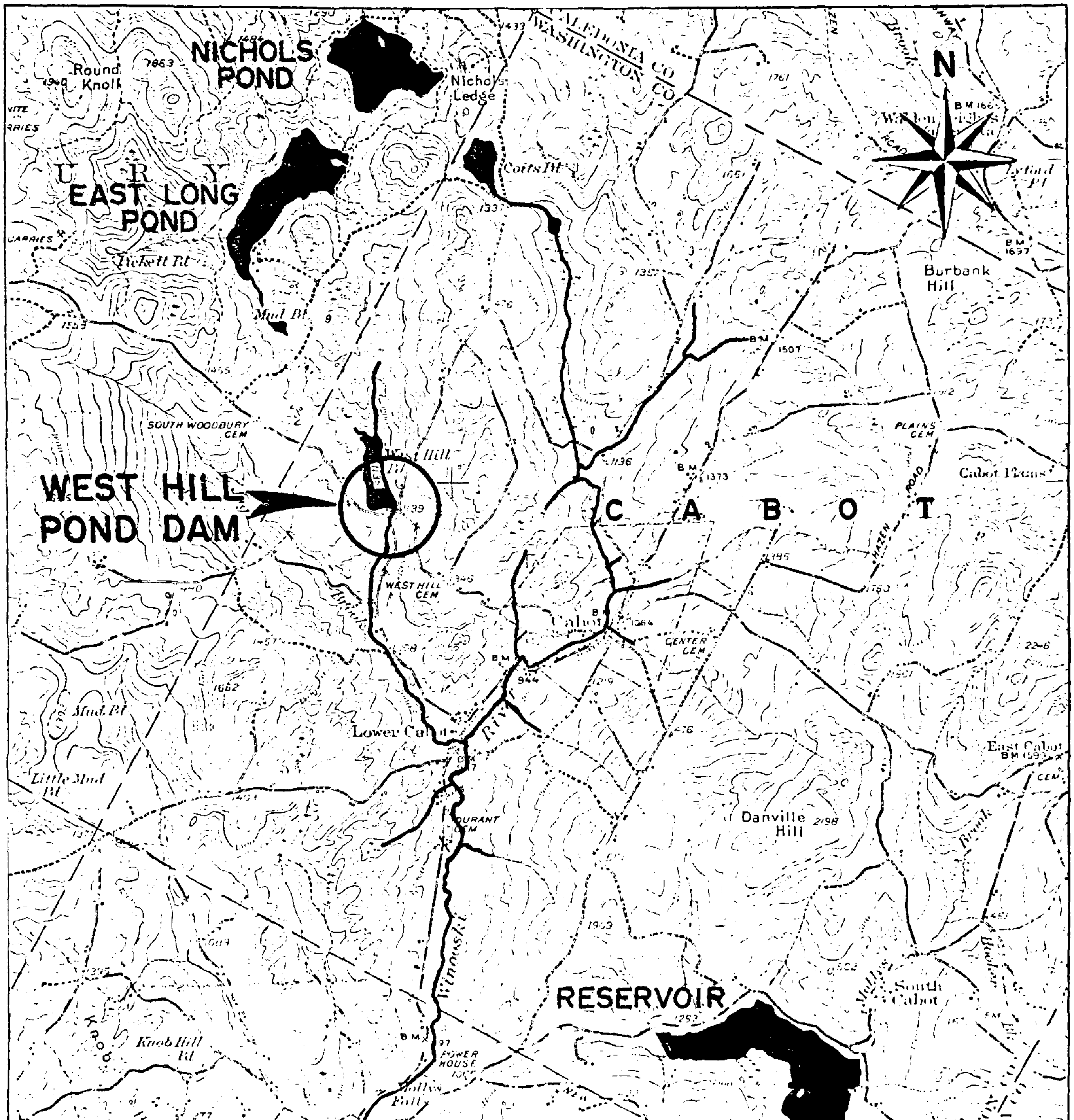
1) Perform technical inspection and evaluation of non-federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-federal interests.

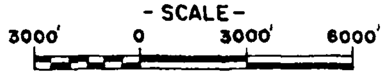
2) Encourage and prepare the states to initiate quickly effective dam safety programs for non-federal dams.

3) Update, verify, and complete the National Inventory of Dams.

(c) Scope

The program provides for the inspection of non-federal dams in the high hazard potential category based upon location of the dams, and those dams in the significant hazard potential category believed to represent an immediate danger based on condition of the dams.





FROM: USGS PLAINFIELD, VT. QUADRANGLE MAPS

QUADRANGLE LOCATION

TIGHE & BOND / SCI CONSULTING ENGINEERS EASTHAMPTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

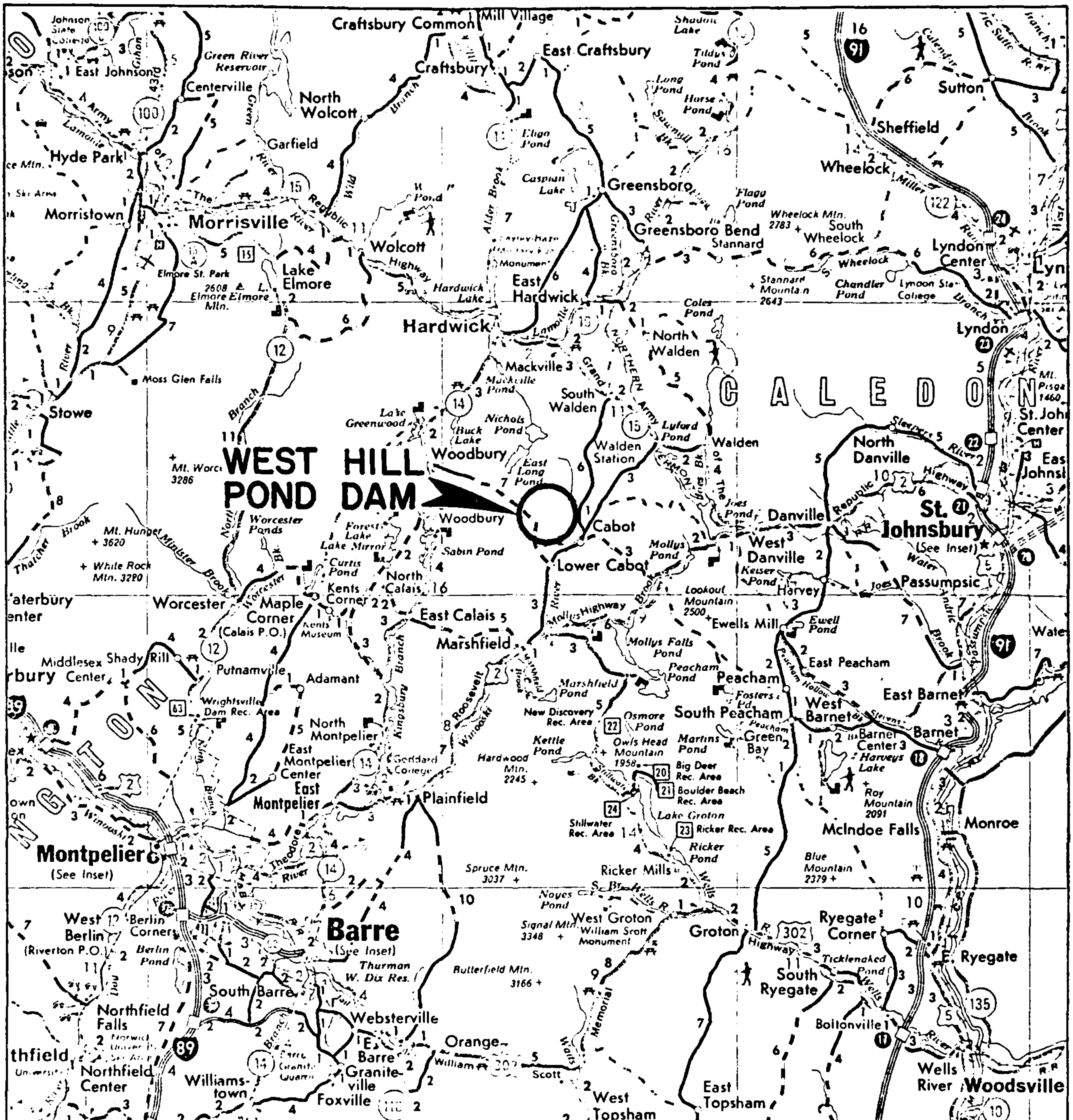
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

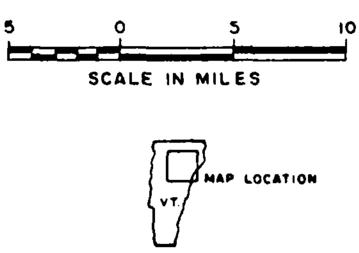
LOCUS PLAN 2

WEST HILL POND DAM (VT. 00083) — CABOT
WASHINGTON COUNTY — VERMONT

SCALE: AS NOTED

DATE: JUNE 1980





TIGHE & BOND / SCI CONSULTING ENGINEERS EASTHAMPTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCUS PLAN I

WEST HILL POND DAM (VT. 00083) CABOT
WASHINGTON COUNTY VERMONT

SCALE: AS NOTED
DATE: JUNE 1980

a) There is a small leak in the dam approximately 1 foot to the right of the low level outlet.

b) A large quantity of debris has accumulated in the downstream channel and adjacent to the spillway impact basin.

c) The soil and stone rubble floor of the spillway has eroded away on the upstream end of spillway.

d) At the left abutment, stones from the downstream dam face have been dislodged.

e) On the left upstream face above the low level outlet, granite slabs have been removed and/or tilted out of position.

f) The wooden low level sluice gate wedge stem is splitting and shows signs of wood rot.

g) Small trees are growing in both the upstream and downstream dam faces.

h) There is brush growth in the earthfill between the stone faces of the dam adjacent to the spillway and on the left end of the dam.

i) Large trees are growing in the left earth abutment.

j) Several stones have fallen into the spillway channel from the channel wall.

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operational Procedures

(a) General

There are no written operational procedures for this dam.

(b) Description of Warning System in Effect

There is no written warning system in effect.

4.2 Maintenance Procedures

(a) General

There is no evidence that any maintenance has been done on the dam for many years.

(b) Operating Facilities

Operation of the sluice gate to regulate the release of water to Jug Brook is the only mechanical item that must be exercised on a regular basis. Visual inspection indicates that the gate is not operated on a regular basis.

There are no other facilities which require operation.

4.3 Evaluation

The dislodged stones in the dam and spillway channel, trees and brush growth on the dam, and condition of the wooden low level pond drain gate as well as the erosion in the spillway and small leak in the dam indicate the complete lack of and need for a routine maintenance program. These problems should be eliminated. The upgraded condition of the dam then could be maintained through a regular inspection and maintenance program.

A formal, written downstream emergency flood warning system should be developed for the dam. This system should include procedures for monitoring of the dam during periods of heavy precipitation.

SECTION 5 - EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

The West Hill Pond Dam is located in Cabot, Vermont on the easterly branch of Jug Brook and is part of the Winooski River watershed. The dam is located approximately one mile upstream of the confluence of the westerly branch of Jug Brook and approximately 1.8 miles upstream of the confluence of the Winooski River in the Village of Lower Cabot. The upper reach of the Winooski River starts in the Town of Cabot.

The West Hill Pond drainage area is approximately 1.9 square miles and is comprised of both open and forested land which rises up to steep hills. There are some dwellings built on the shore of the Pond with a few farmsteads on the surrounding hills. Immediately downstream of the dam there is a single family dwelling (see photo No. 8). However, between this dwelling and the confluence of Jug Brook and the Winooski River, there are only a few dwellings lying within the Jug Brook Valley. Most of the land below the dam is open land or covered with a light growth of brush.

The dam itself is 202 feet long and 11.1 feet high. The dam is constructed with local field stones as a rock rubble dam with earthfill. Both upstream and downstream faces of the dam are vertical. The dam has a low level pond outlet used to regulate the flow in Jug Brook and a spillway which discharges brook flows greater than that which is maintained by the low level pond outlet.

5.2 Design Data

There are no plans or design data available for review of the hydraulic or hydrologic features of the West Hill Pond Dam. The dam was built in 1820 by Avery Atkins. The U.S.G.S. mapping shows an elevation of 1135 (NGVD) for the water level. It has been assumed that this is the elevation of the crest of the spillway and the normal pool elevation.

5.3 Experience Data

No records of flow or stage are known to be available for the West Hill Pond Dam, No. VT 00083.

5.4 Test Flood Analysis

For test flood analysis in this Phase I report, the hydrologic conditions of interest are those required to assess the potential for overtopping the dam. To conduct such an assessment, the storage and discharge characteristics are required. There were, however, no hydraulic or hydrologic design calculations assessing these conditions for inclusion in this Report.

The selection of the test flood for this Report is based on the Corps of Engineers "Recommended Guidelines for Safety Inspection of

Dams." Under these guidelines, the West Hill Pond Dam with a SMALL size classification and SIGNIFICANT hazard potential should be tested against a test flood ranging from a 100 year frequency storm to 50% of the "Probable Maximum Flood" (½ PMF). Since the data available on the downstream hazard area is limited to USGS mapping at a scale of 1 inch equals 1 mile and to the inspection team's observations, a conservative analysis using the ½ PMF test storm has been selected.

The determination of the 1/2 PMF test flood was based on the Corps of Engineers "Preliminary Guidance for Estimating Maximum Probable Discharges in Phase I Dam Safety Investigations" March 1978, curve titled Maximum Probable Flood Peak Flow Rate. Using this curve for mountainous terrain, a unit discharge of 2580 cfs per square mile at full PMF is extrapolated for a drainage area of 1.9 square miles. The resulting test flood for West Hill Pond Dam is 2450 cfs for the 1/2 PMF requirement. This test flood has been routed through the reservoir using the iteration process as outlined in the above-referenced Corps of Engineers March 1978 guide.

The routing analysis assumes that the low level pond outlet is closed during the test storm. This outlet cannot be readily opened and requires bringing a piece of machinery with lifting capacity to the dam in order to lift the wooden gate to the open position. For this reason, only the ungated spillway capacity is included in the routing analysis. It should be noted that including the capacity of the low level pond outlet will not result in a substantial reduction in the extent of overtopping of the dam by the routed test flood outflow.

The results of routing the 1/2 PMF test flood through the reservoir indicates that the storage capacity of the impounded area will reduce the test flood inflow of 2450 cfs to an outflow of 1960 cfs. This calculation was based on having the normal water level in the reservoir at the spillway crest (Elev. 1135±) at the start of the storm. The total discharge capacity of the spillway with the water level at the top of the dam is 38 cfs, which is about 2% of the routed test flood outflow. With these assumptions, the dam is overtopped by about 2.3 feet.

Including the capacity of the low level pond outlet the total discharge capacity is approximately 127 CFS with the water level at the top of the dam. This is about 6.5% of the previously listed test flood outflow from the reservoir.

5.5 Dam Failure Analysis

A dam failure analysis using procedures in the Corps of Engineers, "Rule of Thumb Guidance for Estimating Downstream Failure Hydrographs," April 1978 was performed for West Hill Pond Dam. Assumed conditions were as follows:

1. Water level prior to breach is at top of dam

2. Stream flow downstream of dam at time of breach is the combined capacity of the spillway and low level pond outlet.

For an assumed breach equal to 40 percent of the dam length computed at half the height of the dam, the breach length is 42.6 feet. The resulting dam failure peak outflow is 2333 cfs. The spillway discharge occurring at the time of the dam failure was not added to the dam break peak outflow because part of the spillway would be taken out by the failure and the residual spillway outflow would be negligible.

The pre-failure spillway outflow is approximately 127 CFS including both the ungated spillway and the gated low level pond outlet. In terms of river stage, this is a negligible flow rate and does not result in threatening flood stages at any of the downstream hazard areas. In addition, the resulting river stages are not significant in the dam failure flow attenuation analysis.

The first area impacted by the dam failure flow is approximately 100 feet downstream of the dam at the road crossing. At this location there is one house. It is estimated that the dam failure flow of 2333 cfs will result in a stage of approximately 7.5 feet, flooding the road to a depth of 4.5 feet. No flooding of the house is expected.

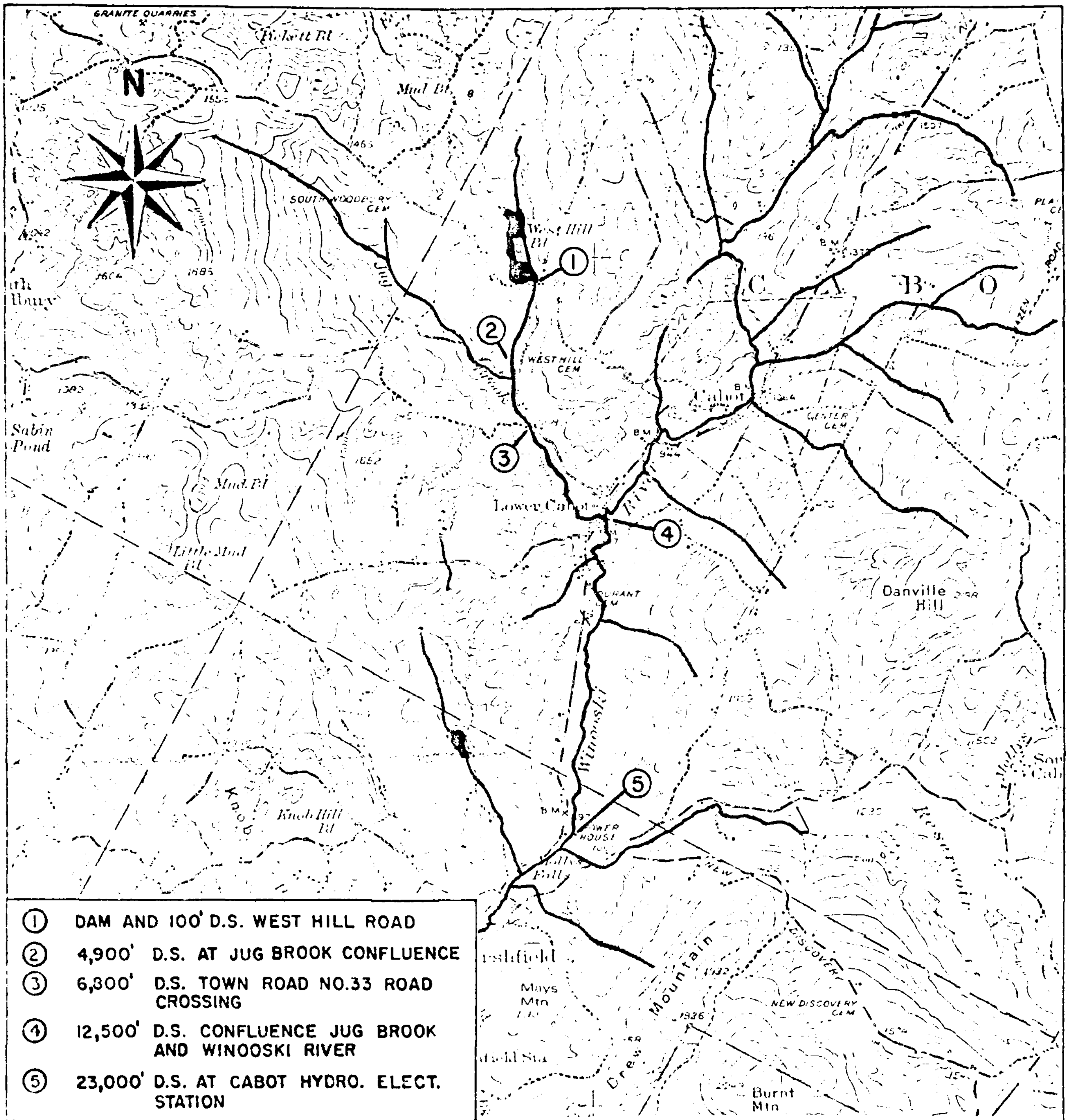
The second damage area is the road crossing and house located just upstream of the west branch of Jug Brook, approximately 4800 feet downstream of the dam. The house would be flooded to a depth of one foot, the road to a depth of approximately two feet. The brook stage at this point would be 4.5 feet and the dam failure attenuated flow would be 1972 cfs.

The third damage area is the third road crossing approximately 6800 feet downstream of West Hill Pond Dam. The dam failure attenuated flow will be 1872 cfs and the brook stage will be 5.0 feet. The combined capacity of the two culverts at this road crossing is 528 cfs. The road is relatively flat at this crossing, therefore, the road will be overtopped but no significant depth of water flow over the road is expected.

Jug Brook crosses the main street in the Village of Lower Cabot and enters the Winooski River approximately 500 feet after the street crossing, 1.8 miles below West Hill Pond Dam. The Jug Brook stage at the confluence of the Winooski River is 4.2 feet with a dam failure attenuated flow of 1567 cfs.

The fourth damage area is the lumber mill dam approximately 500 feet downstream of the Jug Brook and Winooski River confluence. The West Hill Pond Dam failure attenuated flow at this point of 1567 cfs combined with the Winooski River average flow of 25 cfs will result in a flow of 1592 cfs at the lumber mill dam. This dam is a concrete gravity dam with a center overflow spillway with an estimated spillway capacity of 776 cfs. The combined West Hill Dam failure flow and the average Winooski River flow will exceed the spillway capacity of this dam and the dam will be overtopped.

Downstream of the Winooski River mill dam, the dam failure attenuated flow will be substantially dissipated by the flat broad river channel and adjoining open meadows. The dam failure flow to the Cabot hydroelectric station will be 945 cfs. The peak discharge for a 25 year storm for the Winooski River is 1006 cfs at the Cabot station. The West Hill Pond dam failure flow will not constitute a serious damage potential at or downstream of the Cabot hydroelectric station.



- SCALE -

3000' 0 3000' 6000'

FROM: USGS PLAINFIELD, VT. QUADRANGLE MAPS

TIGHE & BOND / SCI CONSULTING ENGINEERS EASTHAMPTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND DOWNSTREAM HAZARD MAP

WEST HILL POND DAM (VT. 00083) CABOT
WASHINGTON COUNTY VERMONT

SCALE: AS NOTED

DATE: JUNE 1980

PROBABLE DOWNSTREAM IMPACT OF DAM FAILURE
West Hill Pond Dam
VT 00083

Number	Location	Number of Houses	Other Damage	Flow Prior to Failure	Brook Stage	Flow After Failure	Brook Stage	Comments
1	Downstream of West Hill Pond Dam	---	1 culvert	127 cfs	--	2333 cfs	7.5 ft	West Hill Road overtopped by 4.5 feet
2	Road crossing above west branch Jug Brook	1	1 culvert	127 cfs	--	1972 cfs	4.5 ft	One house flooeded to depth of 1 ft. possible loss of life
3	Road crossing	---	1 culvert	133 cfs*	--	1872 cfs	5.0 ft	Road overtopped a few inches
4	Winooski River Dam at Village of Lower Cabot	---	---	158 cfs*	--	1592 cfs	4.2 ft	Dam overtopped
5	Cabot Hydro. Elect.	---	---	158 cfs	--	945 cfs	4.1 ft	No damage

* includes average annual flow from tributary streams

SECTION 6 - EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

During the visual inspection of the dam, one condition was noted that warrants further investigation. The small leak in the dam adjacent to the low level pond outlet should be investigated to determine the effect on the earthfill between the rock walls.

6.2 Design and Construction Data

There are no plans or other records of design or construction for the West Hill Pond Dam.

The owner of the dam reported that he has observed approximately one foot of water passing over the full length of the dam with no resulting damage.

6.3 Post Construction Changes

There have been no reported modifications to the dam since its construction in 1820. During the visual inspection no modifications to the dam were observed.

6.4 Seismic Stability

The West Hill Pond Dam is located in Seismic Zone 2. According to the recommended Corps of Enbineers' guidelines, a seismic analysis is not warranted.

SECTION 7 - ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

(a) Condition

The dam and its appurtenances are generally in FAIR condition due to the leak in the dam adjacent to the low level pond drain, the tree and brush growth and the deterioration of the spillway discharge channel.

(b) Adequacy of Information

The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past-performance history and sound engineering judgment.

(c) Urgency

The recommendations and remedial measures described herein should be implemented by the owner within one year of receipt of this Phase I Inspection Report.

7.2 Recommendations

The recommendations of this Phase I investigation are that the following additional studies be made under the supervision of a qualified registered professional engineer:

(a) Determine the cause of the leak in the face of the dam adjacent to the low level outlet.

(b) Determine the suitability and value of the existing sluice gate under emergency operating conditions and implement improvements.

(c) Determine the improvements necessary to provide adequate spillway capacity.

The owner should implement the recommendations of the engineer.

7.3 Remedial Measures

The recommendations of this Phase I investigation are that the following remedial and/or maintenance items be carried out:

(a) Remove debris from the downstream spillway channel.

(b) Replace the missing stone in the floor of the spillway and grout all voids and spaces.

(c) Remove the large trees and stumps in the left abutment and reset the stone face of the dam.

(d) Remove the small trees growing in the upstream and downstream faces of the dam.

(e) Remove brush and roots from the earthfill on top of the dam and fill root hole excavations with suitable material.

(f) Replace the stones in the spillway channel wall that have fallen into spillway channel.

(g) Develop an "Emergency Action Plan" that will include an effective preplanned downstream warning system, locations of emergency equipment, materials and manpower, authorities to contact and potential areas that require evacuation and monitoring of the dam during and immediately after periods of heavy rainfall.

(h) Institute a program of annual technical inspection by a registered professional engineer qualified in dam design and inspection.

7.4 Alternatives

There are no practical alternatives to the above recommendations.

APPENDIX A

INSPECTION CHECKLIST

INSPECTION CHECK LIST

PARTY ORGANIZATION

PROJECT West Hill Pond Dam

DATE April 9, 1980

TIME

WEATHER Overcast

W.S. ELEV. ______ U.S. ______ DN.S.

PARTY:

1. John W. Powers, P.E., Project Manager
2. George H. McDonnell, P.E., Hydrology/Hydraulics
3. Edward A. Moe, P.E., Soils/Hydraulics
4. Paul B. Hatch, P.E., Civil
5.
6.
7.
8.
9.
10.

PROJECT FEATURE	INSPECTED BY	REMARKS
1. All project features were inspected by all party members.		
2.		
3.		
4.		
5.		
6.		
7.		
8.		
9.		
10.		

INSPECTION CHECK LIST

PROJECT West Hill Pond Dam DATE ____________

PROJECT FEATURE ____________ NAME ____________

DISCIPLINE ____________ NAME ____________

AREA EVALUATED	CONDITIONS
DAM EMBANKMENT	
Crest Elevation	See Plans
Current Pool Elevation	13" below emergency spillway
Maximum Impoundment to Date	Unknown
Surface Cracks	None
Pavement Condition	No pavement
Movement or Settlement of Crest	None apparent
Lateral Movement	None apparent
Vertical Alignment	Satisfactory
Horizontal Alignment	Satisfactory
Condition at Abutment and at Concrete Structures	Some stones dislodges left end of dam, trees growing on dam & at left abutment
Indications of Movement of Structural Items on Slopes	None apparent
Trespassing on Slopes	Yes, path across top of dam
Vegitation on Slopes	grass, brush, small trees
Sloughing or Erosion of Slopes or Abutments	none apparent
Rock Slope Protection - Riprap Failures	No rock slope protection
Unusual Movement or Cracking at or near Toes	None apparent
Unusual Embankment or Downstream Seepage	Yes, leak on right side of gated low level outlet through rock face of dam.
Piping or Boils	None observed
Foundation Drainage Features	N/A
Toe Drains	N/A
Instrumentation System	None

INSPECTION CHECK LIST

PROJECT West Hill Pond Dam	DATE
PROJECT FEATURE	NAME
DISCIPLINE	NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - INTAKE CHANNEL AND INTAKE STRUCTURE	
a. Approach Channel	Not Applicable
Slope Conditions	
Bottom Conditions	
Rock Slides or Falls	
Log Boom	
Debris	
Condition of Concrete Lining	
Drains or Weep Holes	
b. Intake Structure	
Condition of Concrete	Granite slope, dislocated, erosion of soil between concrete approach wall and spillway as a result of spillway capacity being exceeded.
Stop Logs and Slots	

Photo 7

Looking northwesterly of spillway, note erosion at concrete header

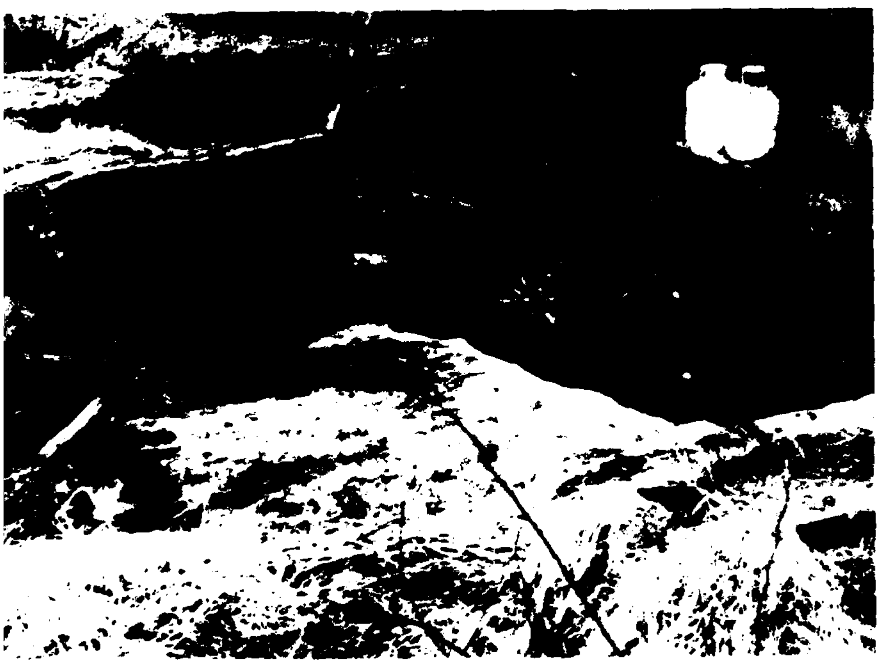


Photo 8

Looking southeasterly at downstream side of spillway

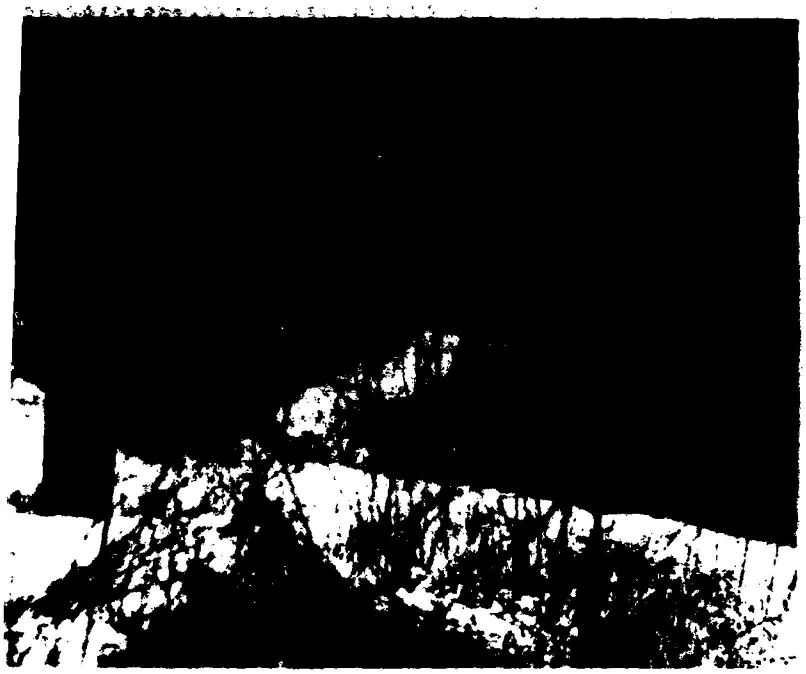


Photo 4

Looking northeasterly at face of dam

Photo 5

Looking at spillway and upstream face of dam

Photo 6

Looling easterly at low level pond outlet sluice gate operator

Photo 1

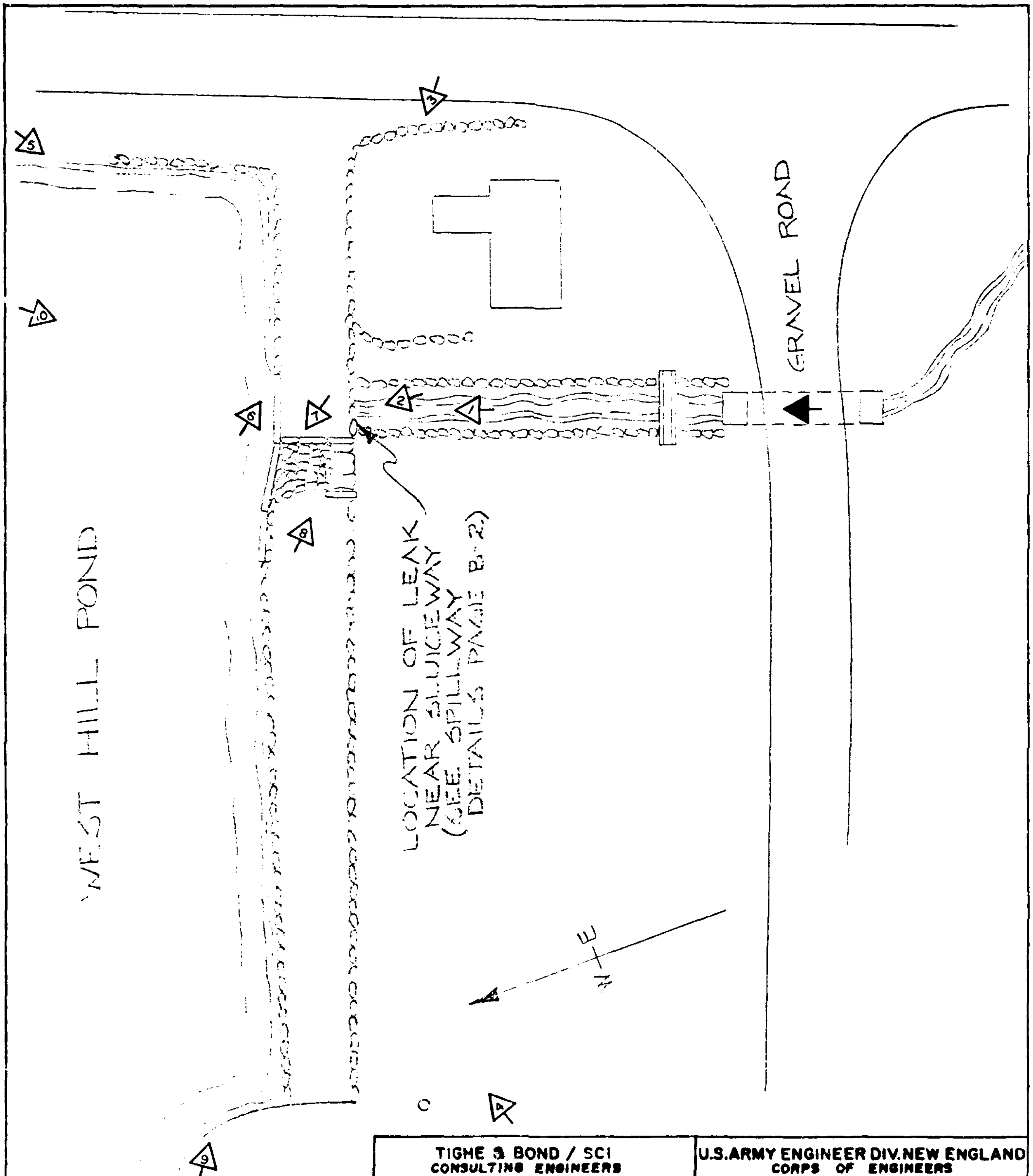
Looking at face of dam, spill-way and low level pond outlet

Photo 2

Looking at face of dam low level pond outlet

Photo 3

Looking northw[illegible]y at face of dam



OVERVIEW

APPENDIX C

TIGHE & BOND / SCI CONSULTING ENGINEERS EASTHAMPTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND ORIENTATION OF PHOTOS

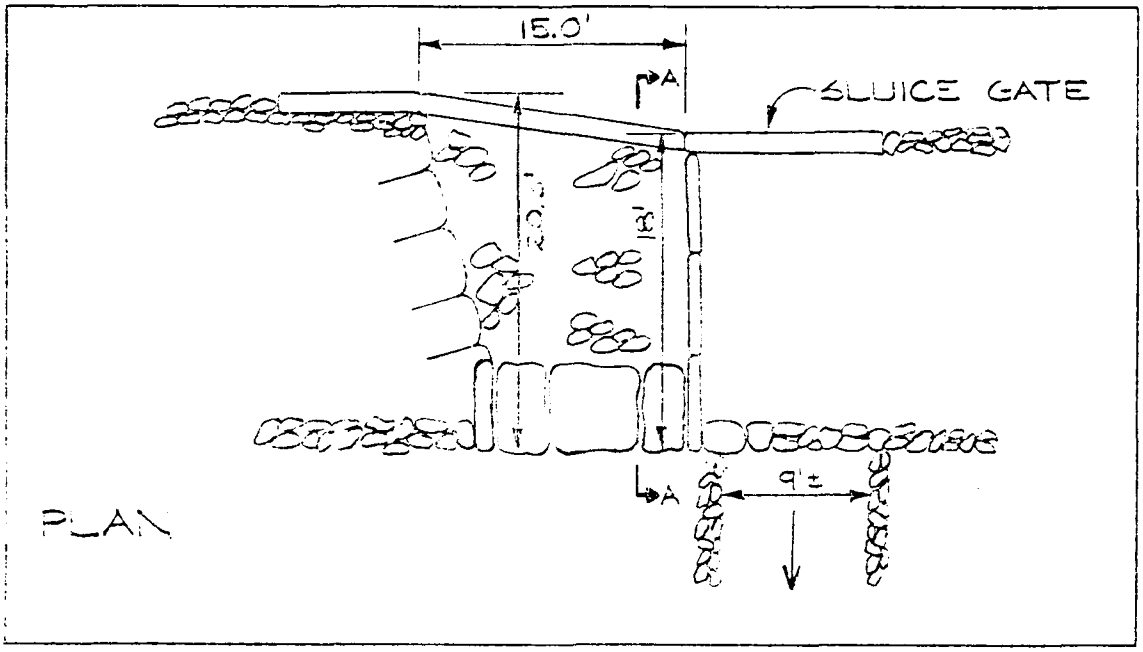
WEST HILL POND DAM (VT. 00083) — CABOT
WASHINGTON COUNTY — VERMONT

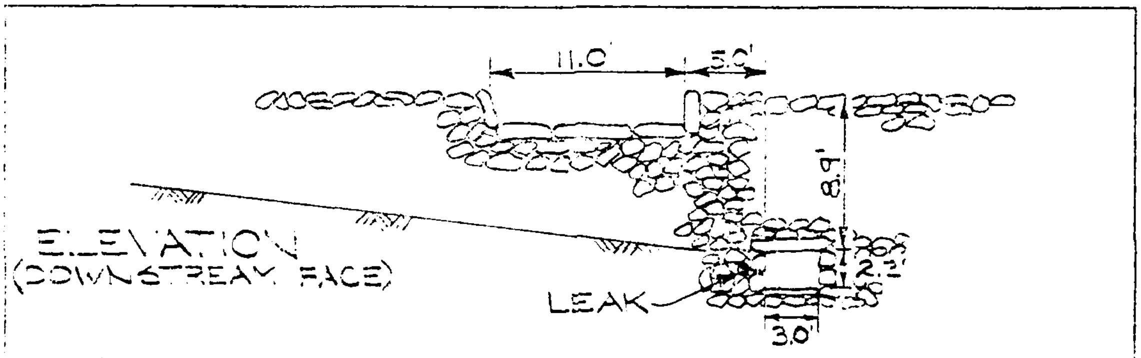
SCALE: N.T.S.

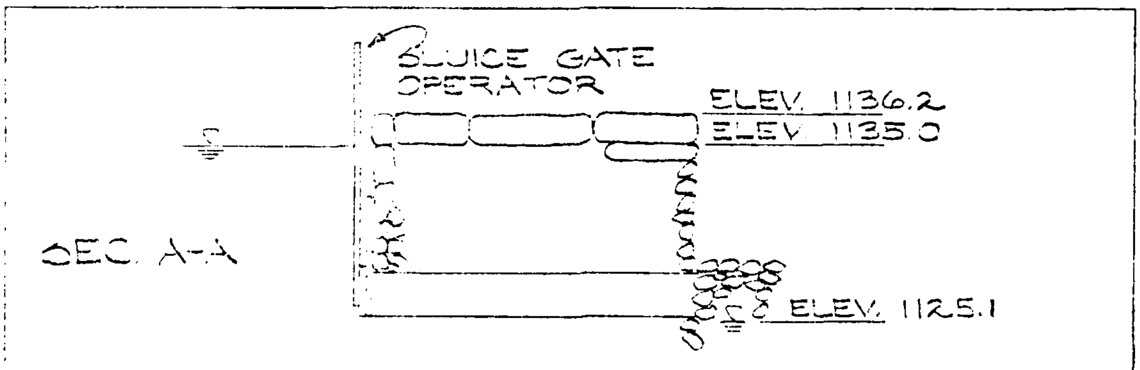
DATE: JUNE 1980

APPENDIX C

PHOTOGRAPHS







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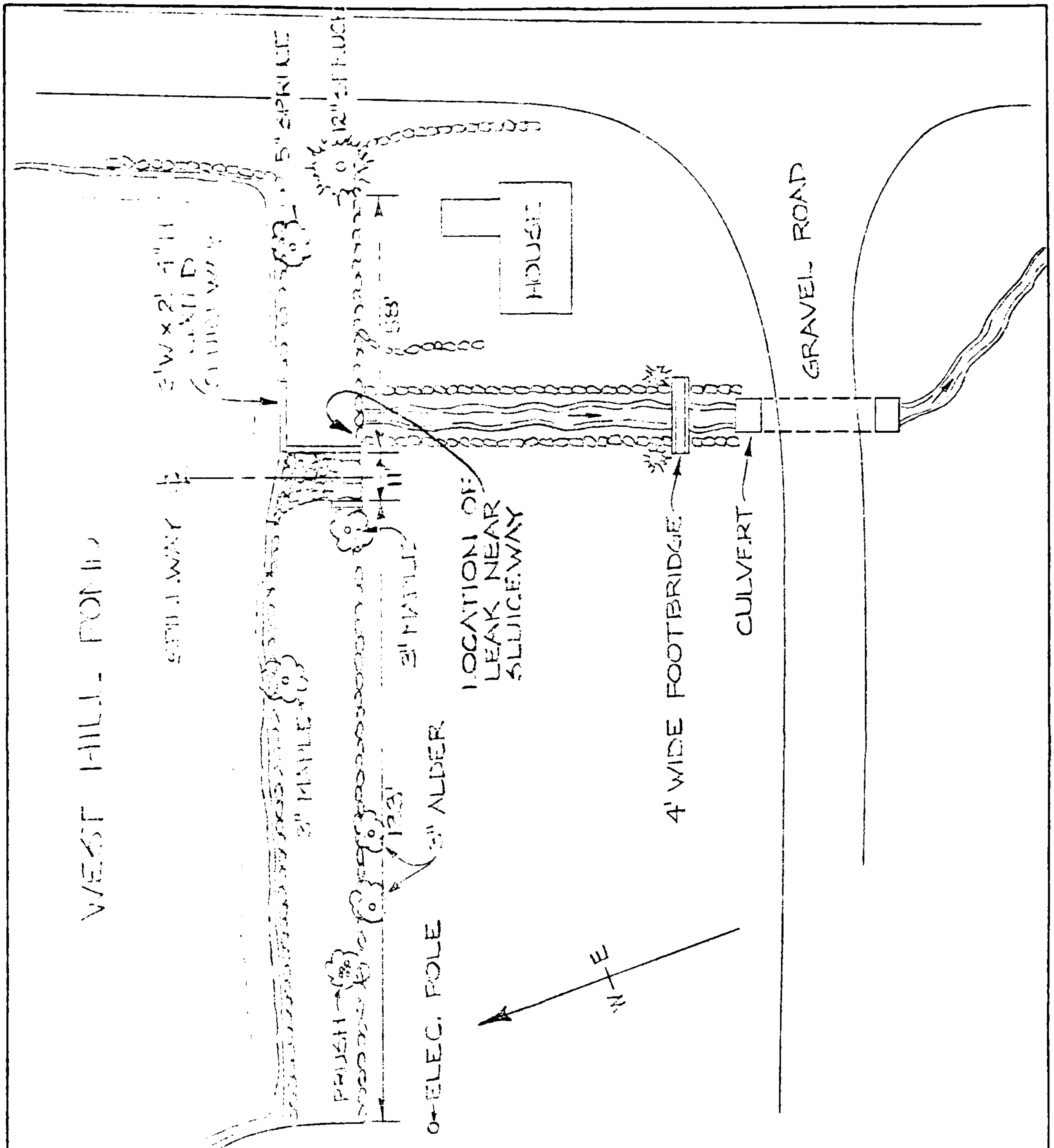
NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

SPILLWAY DETAILS

WEST HILL POND DAM (VT. 00083) CABOT
WASHINGTON COUNTY VERMONT

SCALE: N.T.S.
DATE: JUNE 1980



TIGHE & BOND / SCI CONSULTING ENGINEERS EASTHAMPTON, MASS.	U.S.ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

PLAN OF DAM SITE

WEST HILL POND DAM (VT. 00083) CABOT
WASHINGTON COUNTY VERMONT

SCALE: N.T.S.
DATE: JUNE 1980

APPENDIX B

ENGINEERING DESIGN AND CONSTRUCTION RECORDS

No records of design or construction are available or know to exist.

Sketches of dam are attached as follows:

Plan of Dam Site B-1

Spillway Details B-2

No boring logs or information are known to exist.

APPENDIX B

ENGINEERING DESIGN AND CONSTRUCTION RECORDS

INSPECTION CHECK LIST

PROJECT West Hill Pond Dam

DATE

PROJECT FEATURE

NAME

DISCIPLINE

NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SERVICE BRIDGE	
a. Super Structure	Not Applicable
Bearings	
Anchor Bolts	
Bridge Seat	
Longitudinal Members	
Under Side of Deck	
Secondary Bracing	
Deck	
Drainage System	
Railings	
Expansion Joints	
Paint	
b. Abutment & Piers	
General Condition of Concrete	
Alignment of Abutment	
Approach to Bridge	
Condition of Seat & Backwall	

INSPECTION CHECK LIST

PROJECT West Hill Pond Dam	DATE
PROJECT FEATURE	NAME
DISCIPLINE	NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS	
a. Approach Channel	Not Applicable
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Approach Channel	
b. Weir and Training Walls	
General Condition of Concrete	
Rust or Staining	
Spalling	
Any Visible Reinforcing	
Any Seepage or Efflorescence	
Drain Holes	
c. Discharge Channel	
General Condition	
Loose Rock Overhanging Channel	
Trees Overhanging Channel	
Floor of Channel	
Other Obstructions	

INSPECTION CHECK LIST

PROJECT West Hill Pond Dam DATE ______

PROJECT FEATURE ______ NAME ______

DISCIPLINE ______ NAME ______

AREA EVALUATED	CONDITION
OUTLET WORKS - OUTLET STRUCTURE AND OUTLET CHANNEL	
General Condition of Concrete	Not Applicable
Rust or Staining	
Spalling	
Erosion or Cavitation	
Visible Reinforcing	
Any Seepage or Efflorescence	
Condition at Joints	
Drain holes	
Channel	
Loose Rock or Trees Overhanging Channel	Rock wall channel, several rocks have fallen into channel, debris, turf sloughed off embankment and rock obstruct portions of channel.
Condition of Discharge Channel	

INSPECTION CHECK LIST

PROJECT West Hill Pond Dam

DATE

PROJECT FEATURE

NAME

DISCIPLINE

NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - TRANSITION AND CONDUIT	
General Condition of Concrete	Not Applicable
Rust or Staining on Concrete	
Spalling	
Erosion or Cavitation	
Cracking	
Alignment of Monoliths	
Alignment of Joints	
Numbering of Monoliths	

INSPECTION CHECK LIST

PROJECT West Hill Pond Dam

DATE

PROJECT FEATURE

NAME

DISCIPLINE

NAME

AREA EVALUATED	CONDITION
OUTLET WORKS - CONTROL TOWER	
a. Concrete and Structural	Not Applicable
General Condition	
Condition of Joints	
Spalling	
Visible Reinforcing	
Rusting or Staining of Concrete	
Any Seepage or Efflorescence	
Joint Alignment	
Unusual Seepage or Leaks in Gate Chamber	
Cracks	
Rusting or Corrosion of Steel	
b. Mechanical and Electrical	
Air Vents	
Float Wells	
Crane Hoist	
Elevator	
Hydraulic System	
Service Gates	Wood gate positioned by hammering wood wedge, gate not observed, wood wedge poor condition
Emergency Gates	None
Lightning Protection System	
Emergency Power System	
Wiring and Lighting System in Gate Chamber	

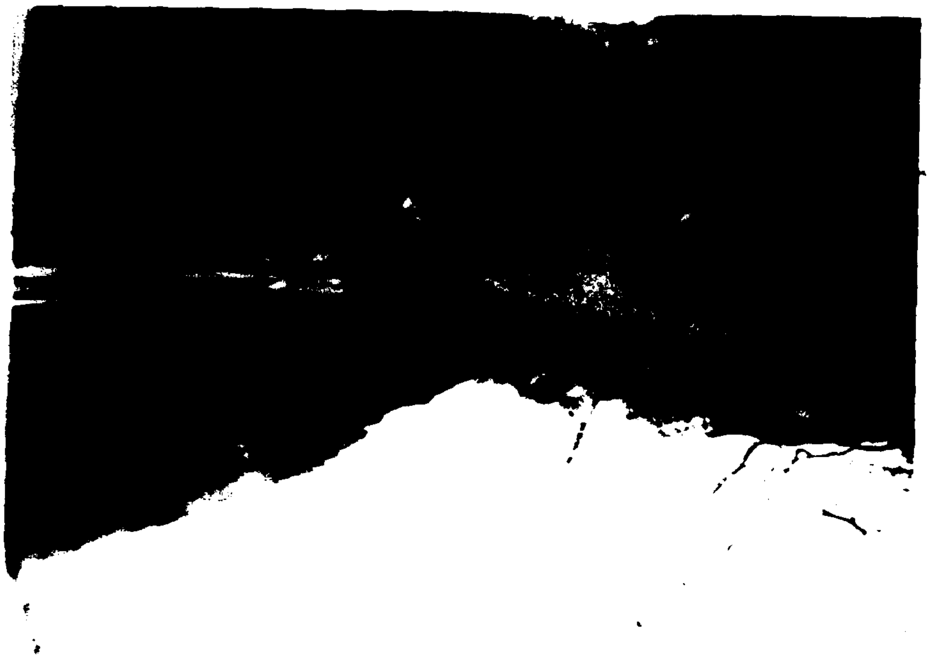


Photo 9

Looking easterly upstream face of dam

Photo 10

Looking southerly, overall view of dam

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

INDEX

checked by: [illegible]

West Hill Pond Dam

Size & Hazard Classification

1. Reference data:

a. No data available for this dam. No drawings available for this dam.

b. Data developed for analysis as noted in calculations.

c. Stream elevation at dam

1135 (USGS Map) $- 9.9$ (field data) $=$ __1125.1__

d. Top of dam

1135 (USGS) $+ 1.2$ (field data) $=$ __1136.2__

e. Height of dam

$1136.2 - 1125.1 =$ __11.1 feet__

2. Outlet:

a. Low stage spillway invert elev. 1125.1

3.0'W × 2.3'H

b. Principal spillway

broad crested weir 11.0' long

at elev. 1135

3. Storage volume vs. pool elevation:

a. Data developed from 15' USGS map (1" = 1 mile)

b. Table I

Elev.	Surface Area (Acres)	Volume (Acre-Ft.)
1125	0.3	0
1135	45	113 ← Spillway
1136.2	49	170 ← Top of dam
1140.0	64	—

4. Classification:

Height of dam = 11.1 ft < 40 ft ⇒ Small

Storage = 170 Acre-ft. < 1000 Ac.-ft ⇒ Small

∴ Size classification is Small

Hazard:

Hazard classification is significant. There is one house located just upstream of the [illegible] road crossing (road has no name) that [illegible] could not [illegible] the [illegible] [illegible], with [illegible] [illegible] currently at this crossing, water [illegible] [illegible] this house to an estimated depth of [illegible] feet.

There are no other structures that are estimated [illegible] [illegible]. There is no industry, commercial [illegible] or [illegible] or [illegible] downstream [illegible] [illegible].

Hazard classification is significant

5. Test Flood selection

In accordance with "Recommended Guidelines for Safety Inspection of Dams" Dept. of the Army, Office of the Chief of Engineers, November 1976 (para 3.5.4), for significant hazard, small size use 100 yr to ½ PMF.

Since data available is limited to USGS map scale 1" = 1 mile and the inspection party observations, to be conservative use ½ PMF.

Test Flood is <u>½ PMF</u>

6. Spillway Analysis

a. Test Flood

I. Drainage Area from USGS map = 1.9 Sq. Mi

II Terrain is mountainous

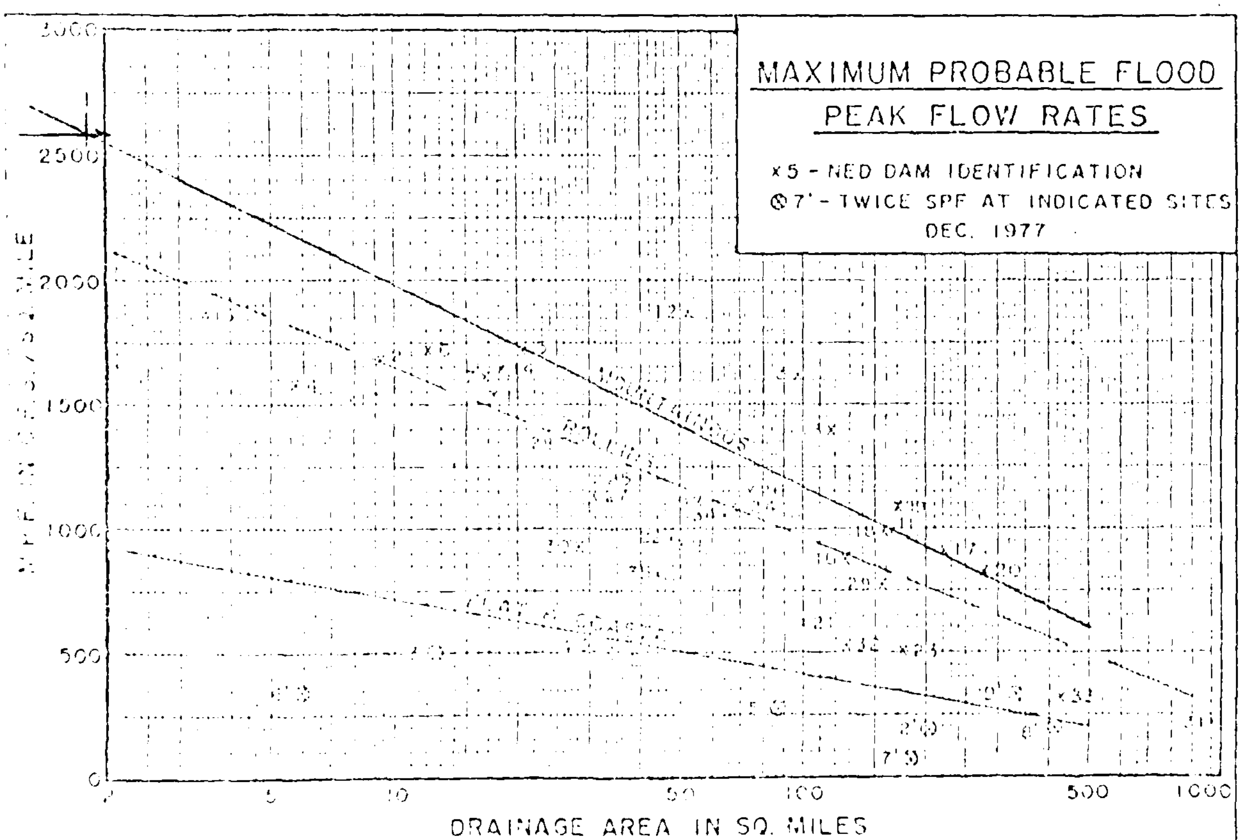
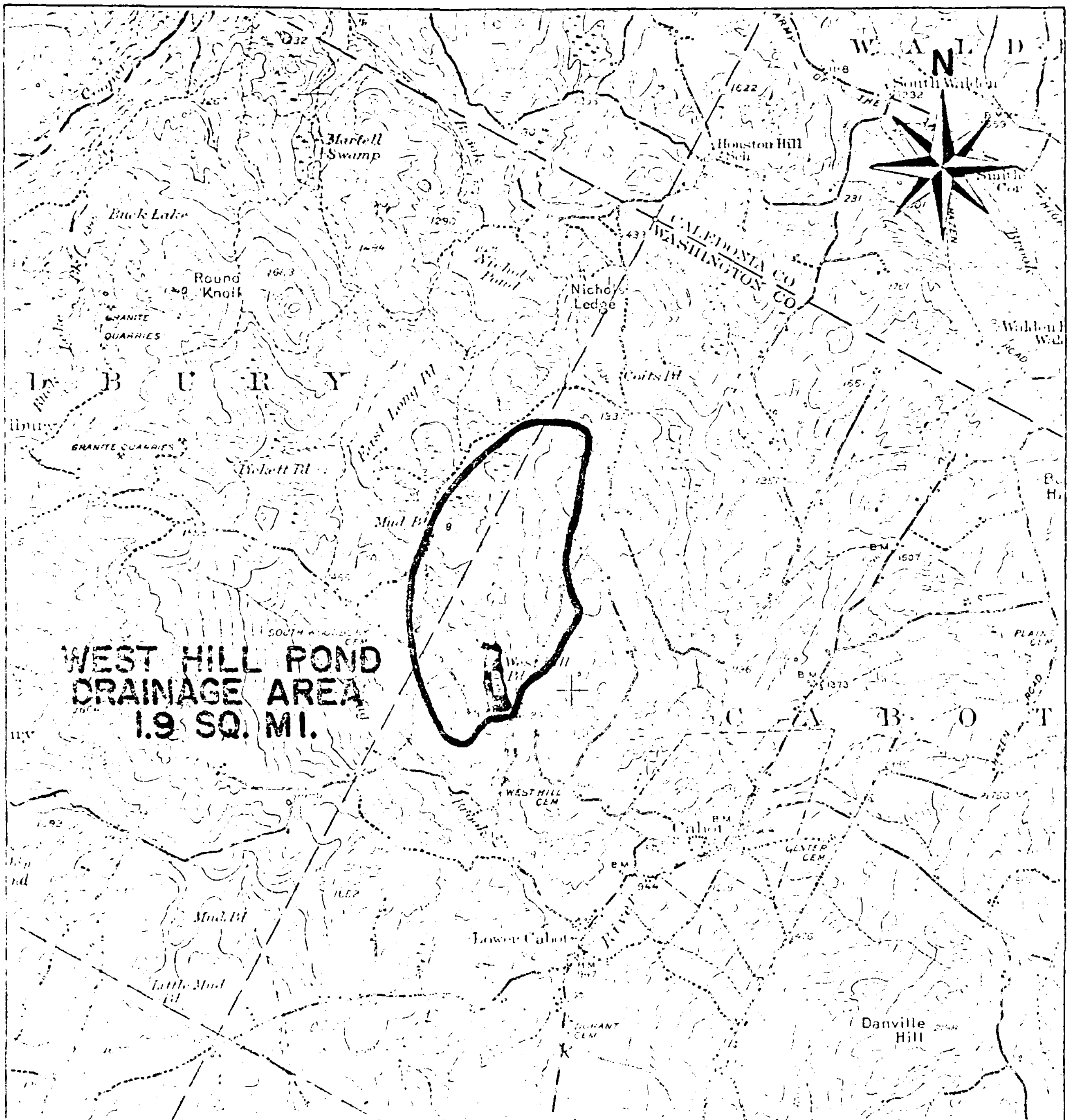


Fig. II



-SCALE-

3000' 0 3000' 6000'

FROM: USGS PLAINFIELD, VT. QUADRANGLE MAPS

TIGHE & BOND / SCI CONSULTING ENGINEERS EASTHAMPTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

DRAINAGE AREA MAP

WEST HILL POND DAM (VT. 00083) CABOT
WASHINGTON COUNTY VERMONT

SCALE: AS NOTED

DATE: JUNE 1980

6. b. Extrapolation of COE provided guide curves "Maximum Probable Flood, Peak Flow Rates" (see pg. 3), unit discharge is 2580 CFS / sq. mi.

c. PMF:

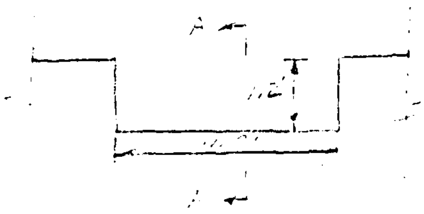
$$2580\ CFS/sq.\ mi \times 1.9\ sq.\ mi = 4902\ CFS$$

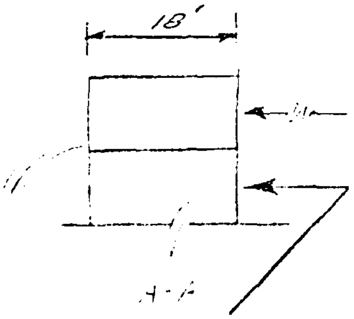
d. ½ PMF therefore is 2451 CFS

7. Spillway Capacity

a. There is a low level spillway which serves as a [illegible] again. The gate on this low level outlet is wood construction, there is no operator to open the gate to the outlet; if the outlet is to be used, equipment must be brought to the dam. For these reasons, it is assumed that the low level outlet is not available to discharge flood waters from the pond. Therefore, only the main [illegible] spillway at the top of dam is available.

c. Spillway discharge versus pond elevation at top of dam:





Assume contractions

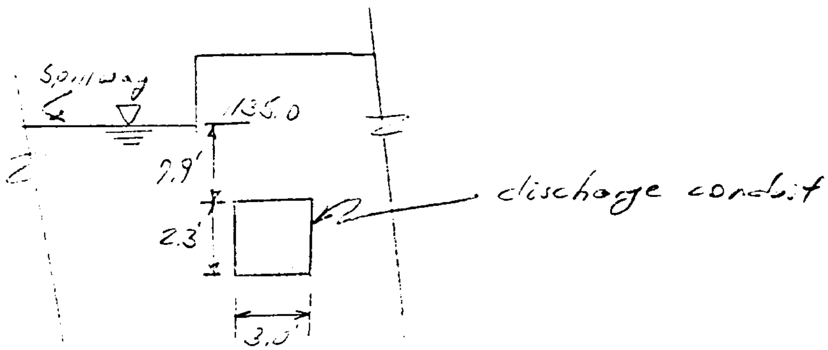
$L' = L - 0.1\,nH$

= [illegible]

= [illegible] ft.

Note: Upstream face of dam appears to be vertical.

Dam outlet discharge capacity:



assume inlet control, from Bureau of Public Roads Hydraulic Eng. Circular No 5

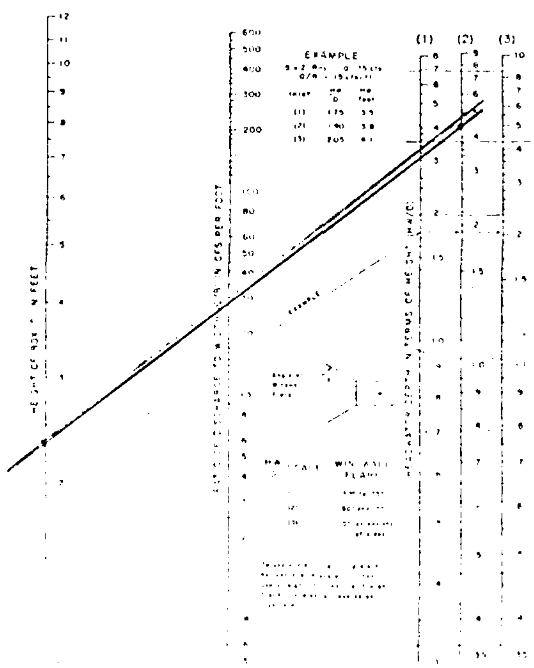
W.L. at spillway crest → $HW/D = (7.9 + 2.3) \div 2.3 = 4.4$

W.L. at top of dam → $HW/D = (8.9 + 2.3) \div 2.3 = 4.9$

$Q/B = 29$ CFS/ft ∴ $Q = 29$ CFS/ft × 3' = 87 CFS

$Q/B = 30$ CFS/ft ∴ $Q = 30$ CFS/ft × 3' = 90 CFS

CHART I



HEADWATER DEPTH FOR BOX CULVERTS WITH INLET CONTROL

1.b. using Francis $Q = 3.33 \cdot L \cdot H^{3/2}$
and Hazen & Williams modifier for flat topped weirs of .80 then

$$Q = (.8)(3.33)(10.76)(1.2^{3/2}) = 39.4 \text{ CFS}$$

39 [illegible] 2451 CFS (½ PMF)

c. The existing spillway is significantly less than the ½ PMF. Observations of debris [illegible] trees on either side of the [illegible] side of the discharge channel substantiate this evaluation. The dam is frequently overtopped.

On this phase I evaluation it is considered prudent to evaluate the dam using the full length of the dam as a spillway.

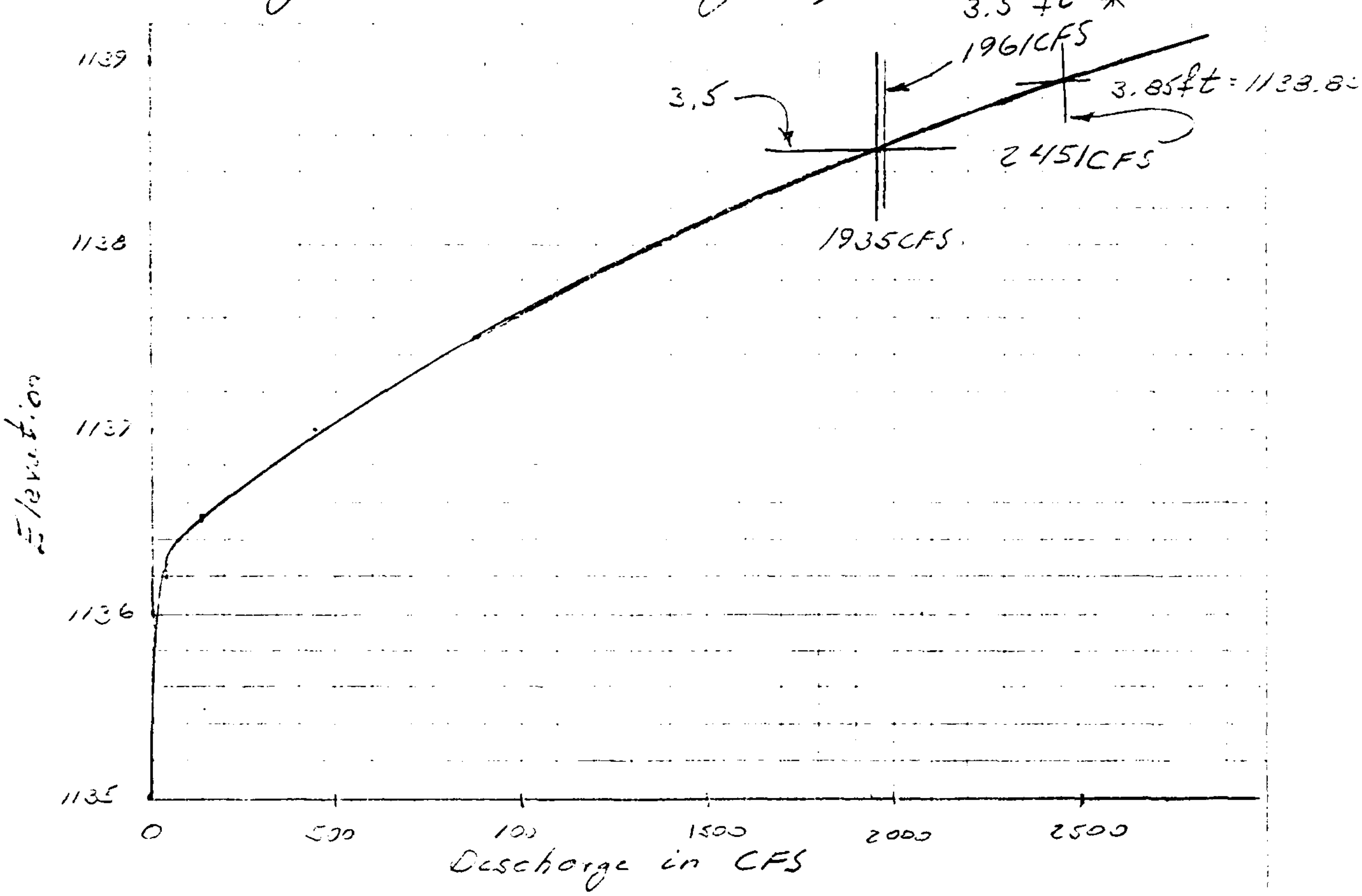
d. [illegible] discharge versus pond elevation using [illegible] length of dam as spillway

[illegible] end contractions, L = 202 ft − 11 ft spillway = 191'

Table II

Elev.	h over dam	h over spillway	Q spillway gated	Q spillway ungated	Q_{dam}	Q_{TOTAL}
[illegible]	.3	1.5	90	53	84 CFS	227 CFS
[illegible]	.8	2.0	93	82	364	539
[illegible]	1.3	2.5	96	[illegible]	[illegible]54	964
[illegible]	[illegible]6	3.0	99	150	[illegible]229	1478
[illegible]	[illegible]	[illegible]	102	[illegible]	[illegible]	2065
[illegible]	[illegible]	[illegible]	108	331	2282	272[illegible]

e. Discharge vs. Elev. (Fig III)



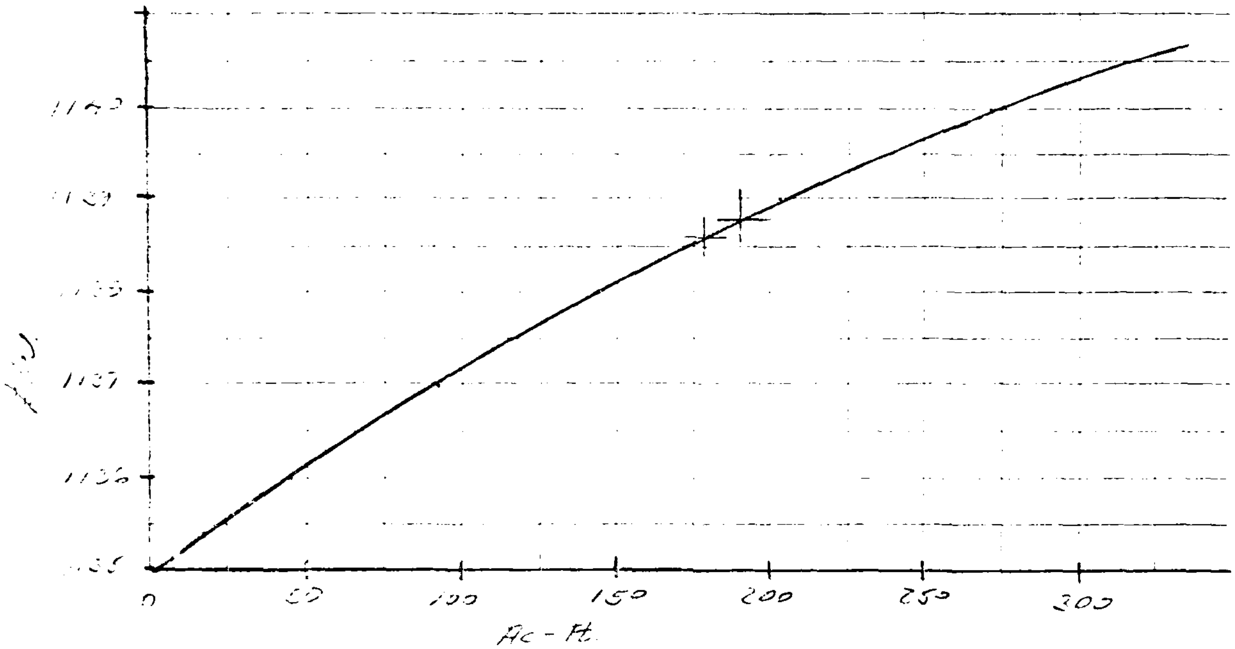
7. Evaluation of surcharge storage w/ test Flood Flow

a. Storage vs. elev. (Table III)

Elev.	Surface Area Ac.	Storage Ac. Ft.
1135	45	0
1136	46	45.5
1137	48	93
1138	[illegible]	142.5
[illegible]	[illegible]	204
[illegible]	[illegible]	[illegible]

[illegible]

b. Surcharge Vol. vs Elev Fig II



c. Max. Surcharge vs. peak outflow Q_{p3} Calc.

Q_{p_1} = 2451 CFS

H to pass Q_p = 1138.8 − 1135 = 3.8 ft.
see Fig II

$STOR_1$ = 192 Ac. Ft.

= 192 Ac. Ft. × [illegible] ÷ [illegible] sq. mi.

= .167 ft. = 2 inch

$Q_{p_2} = Q_{p_1} \times (1 - \frac{STOR_1}{19.2})$ = 2451 × (1 − $\frac{2}{19.2}$) = 1935 CFS

H [illegible] see Fig II = 3.5 ft. = 1138.5

[illegible] Fig II = 190 Ac. Ft.

[illegible] = $\frac{192 + 190}{2}$ = 186 Ac. Ft.

[illegible] = .161 ft = 1.9 inch

[illegible] = 2451 × (1 − $\frac{1.9}{19.2}$) = 1961 CFS

H = 3.5 ft = 1138.5

[illegible] West Hill Pond Dam

2.C H for 570 [illegible] = 3.6 ft (compare to 3.5)

agreement OK

Discharge utilizing storage is 1961 CFS

1C [illegible] of spillway capacity

The max. spillway capacity without overtopping [illegible] CFS [illegible] the spillway is [illegible] when compared to required discharge capacity.

[illegible] consideration is given to allowing overtopping [illegible] the discharge [illegible] using surcharge storage [illegible] 1961 C [illegible] which [illegible] result in overtopping [illegible] 3.5 [illegible]. There is no evidence [illegible] embankment protection of dam [illegible] that the dam [illegible] however since [illegible] a determination [illegible] overtopping that [illegible] capable [illegible]. There [illegible] of [illegible].

[illegible]

Downstream conditions with Dam Failure

a. Use "Rule of Thumb Guidance for Estimating Downstream Dam Failure Hydrographs" April '78 [illegible] CORPS

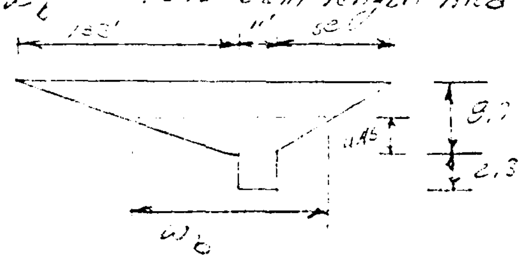
[illegible]

1. Reservoir storage at failure 292.5 Ac-Ft
(See [illegible] 4.C above)

II. Peak failure outflow Q_{p1} determination

$Q_{p1} = 8/27 \cdot W_b \sqrt{g} \; Y_0^{3/2}$

where W_b = 40% dam length mid height



$(152+53)\frac{1}{2} + 11 = 106.5$

$W_b = 106.5 \times 40\% = 42.6$

Y_0 = Total ht. from river bed to pool level at failure
= 1304 3.0 − 1185.1 = 14.7

$\therefore Q_{p1} = 8/27 \times 42.6 \times \sqrt{32.2} \times 14.7^{3/2} = \underline{\underline{4031}}$ CFS

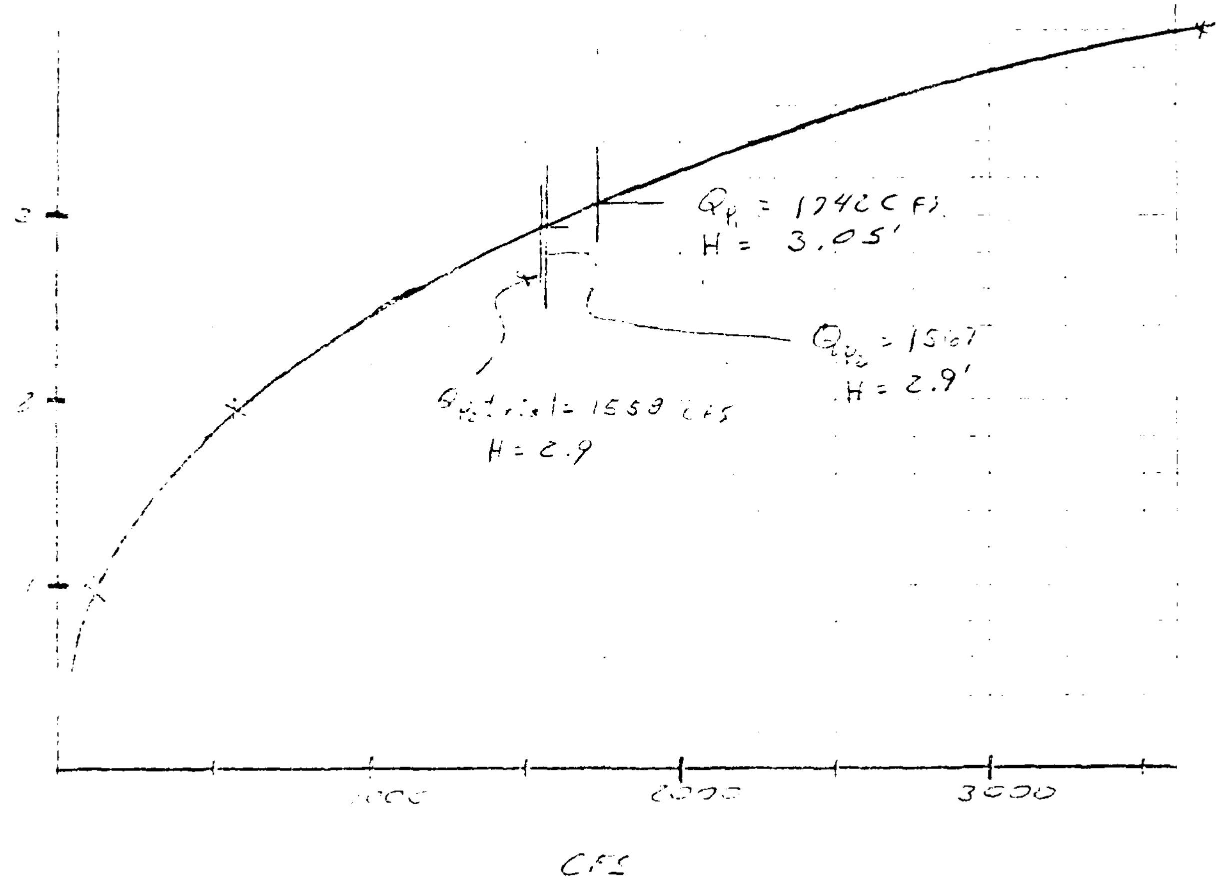
[illegible]

[illegible] $^{3/2}$ = ___ CFS

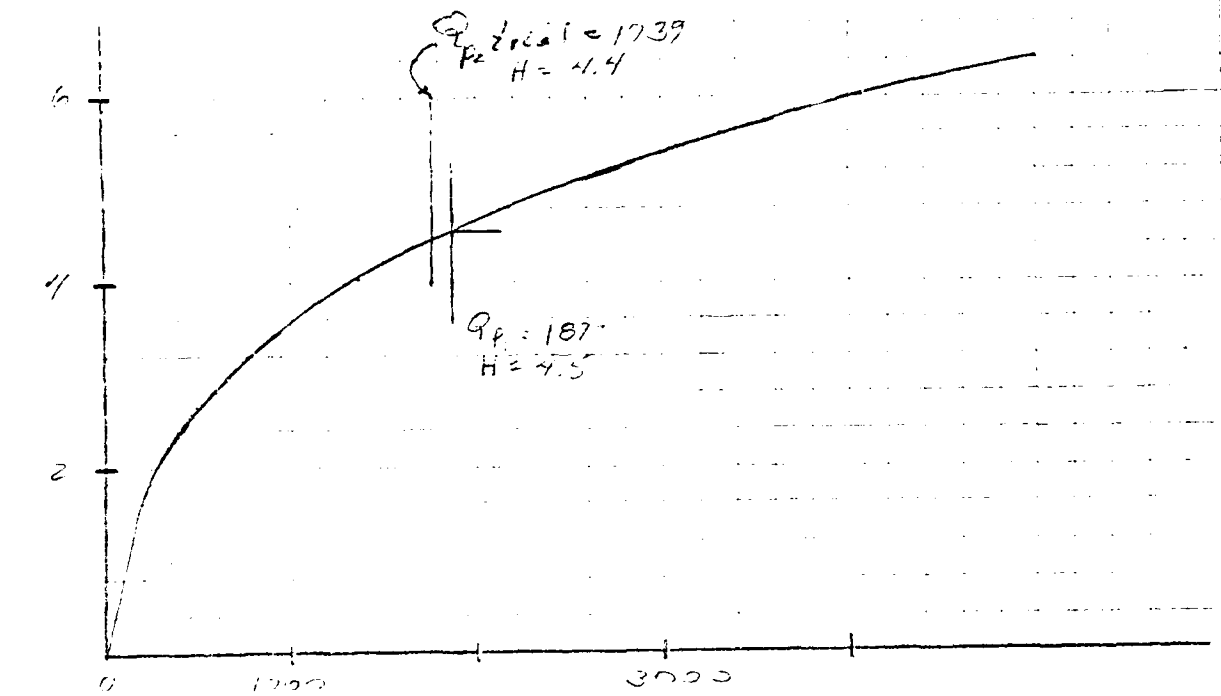
I

$$Q = \frac{1.486}{.04} \times A \times R^{2/3} \times .0095^{1/2}$$
$$= A \times R^{2/3} \times 3.62$$

H	WP	A	R	Q cfs
1	80	40	1/2	91
2	160	160	1	579
3	240	360	1.5	1909
4	320	640	2	3686



West Hill Pond Dam



CFS

$V_1 = 2600' \times 10 \times 4.5^2 \div 43{,}560 = 12.1$ Ac. Ft.

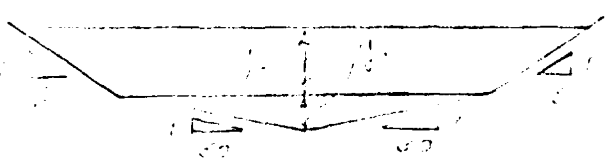
$Q_{p2}(\text{trial}) = 1872\left(1 - \frac{12.1}{170}\right) = 1739$ CFS

$V_2 = 2600 \times 10 \times 4.4^2 \div 43{,}560 = 11.6$ Ac. Ft.

$Q_{p2} = 1872\left(1 - \frac{(12.1 + 11.6) \div 2}{170}\right) = 1742$ CFS

H = 4.4'

Impact area at Village of Lower Grant before crossing Main Street



e.III. (b) for corrugated pipe

$n = .015$

$\therefore f = 185 \dfrac{\overline{.015}^2}{4^{1/3}} = .02622$

$H = 4.0 + 2.2 = 6.2$

$$\left(\frac{6.2}{4} - 1 + \frac{.75}{4}\right) = \frac{8}{\pi^2 g}\left(1.5 + \frac{.02622 \times 35}{4}\right)\left(\frac{Q}{4^{5/2}}\right)^2$$

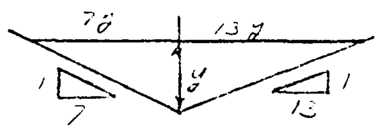
$Q = 132$ CFS

$\Sigma Q_{culverts} = 396 + 132 = 528$ CFS < 1892 CFS (Q_{P2}) (pg 21)

Road overtopped, nearest house at elev 1025, river @ elev. 1008

f. III Impact area before Village of Lower Cobot

Reach $L = 2600$ ft $\qquad n = .04$, $S = .02154$



$Area = \frac{1}{2} \cdot 20y^2 = 10y^2$

Wetted Perimeter =

$(1+7^2)^{1/2} + (1+13^2)^{1/2} = 20.1y$

$Q = \dfrac{1.486}{.04} \times A \times R^{2/3} \times .02154^{1/2}$

$= 5.452\, A\, R^{2/3}$

y	WP	A	R	Q CFS
[illegible]	20.1	10	.5	34
2	[illegible]	40	1	217
3	[illegible]	[illegible]	1.5	642
4	[illegible]	[illegible]	2	1353
5	[illegible]	250	2.5	2502
6	[illegible]	360	3	4987

11. e. III

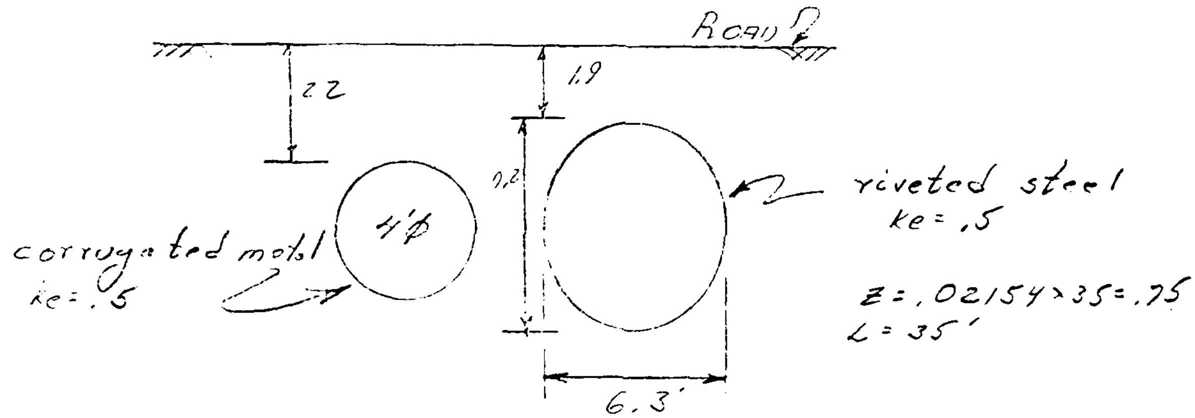
$$V_1 = 1950 \times (a \times 5.7^2) \div 43{,}560 = 9.3 \text{ Ac. Ft}$$

$$Q_{P2} \text{ trial} = 1978\left(1 - \frac{9.3}{170}\right) = 1870 \text{ CFS}$$

$$V_2 = 1950\,(a \times 5.0^2) \div 43{,}560 = 8.9 \text{ Ac. Ft}$$

$$Q_{P2} = 1978\left(1 - \frac{(9.3 + 8.9) \div 2}{170}\right) = 1872 \text{ CFS}$$

Road Crossing



Determine capacity of culverts with water at road surface

(a) riveted pipe

consider as circular pipe with dia =

$$(6.3 + 7.2) \div 2 = 6.75 \text{ ft.}$$

$$n = .016$$

$$\therefore f = 185 \frac{.016^2}{6.75^{1/3}} = .02506$$

$$H = 2.2 + 1.9 = 9.1$$

$$9.1 + \frac{.75}{6.75} = \frac{8}{\pi^2 g}\left(1 + .5 + \frac{.02506 \times 35}{6.75}\right)\left(\frac{Q}{6.75^2}\right)^2$$

$$Q = 296 \text{ CFS} > 6 + 377 \text{ (Spillway Cap.)}$$

[illegible]

11. e III Impact area upstream second road crossing (road is unnamed)

Reach $L = 1950'$ $n = .04$

$S = \frac{1050-1008}{1950} = .02154$

looking upstream

Area $= 8y^2$

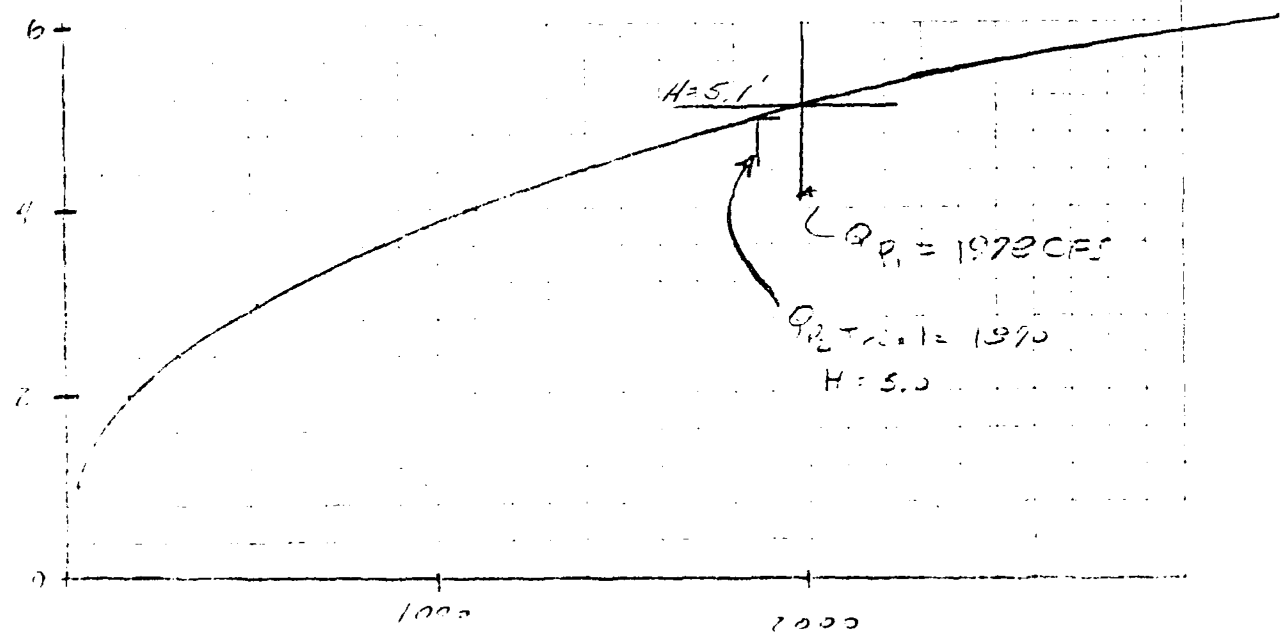
Wetted Parameter $= 2\times(1+8^2)^{1/2}y$

$= 16.12y$

$Q = \frac{1.486}{n} \times A \times R^{2/3} \times S^{1/2}$

$= 5.452$

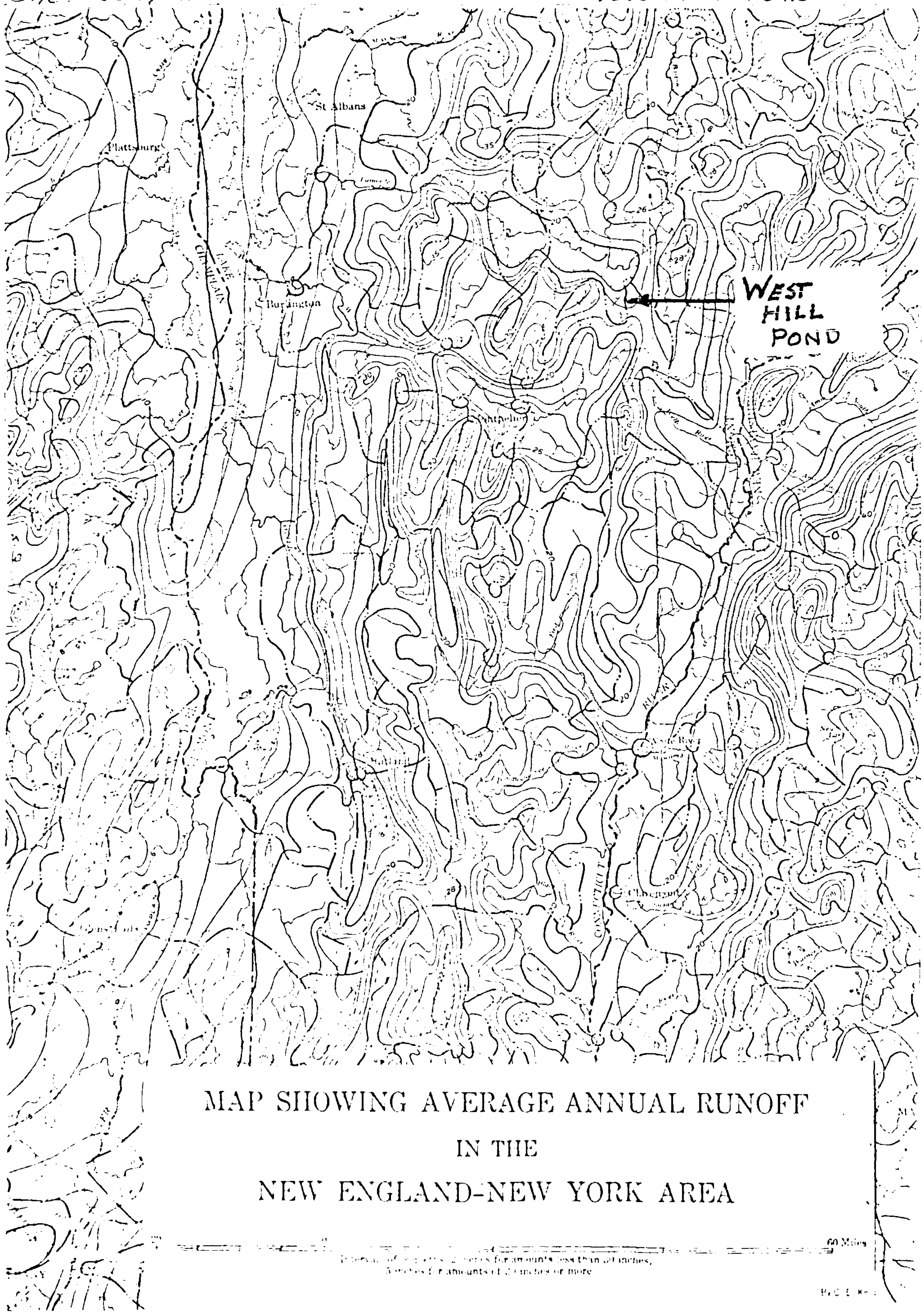
y	WP	A	R	Q CFS
1	16.12	8	.5	27
2	32.24	32	1	174
3	48.36	72	1.5	513
4	64.48	128	2	1105
5	80.6	200	2.5	2004
6	96.72	288	3.	3262



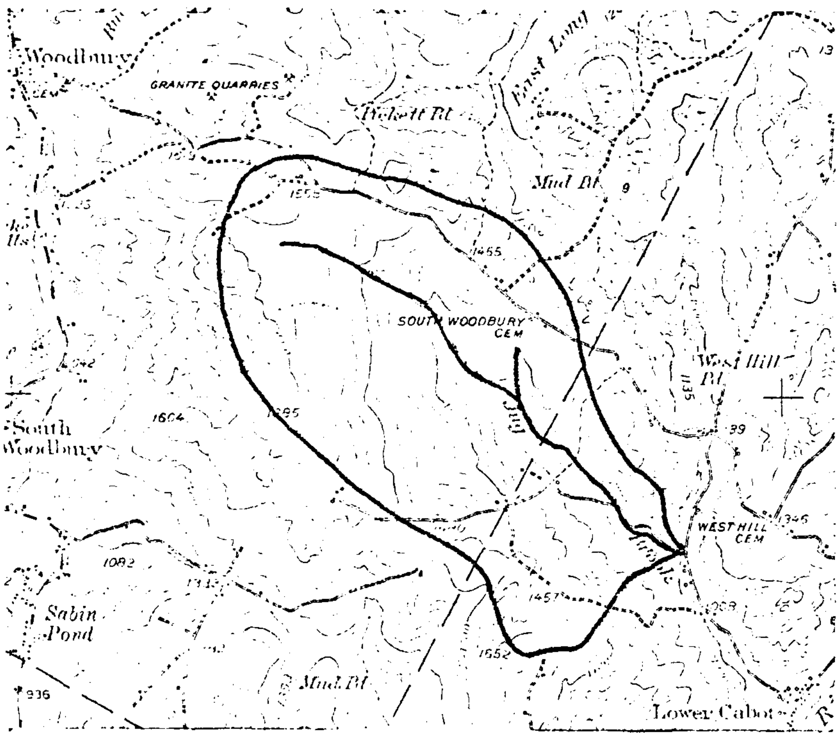
CFS

Checked by: F...

West Hill Pond Dam



11. e III Jug Brook contribution to stream flow (assume Jug Brook Qavc)



Jug Brook drainage area = 3.72 Sq. mi
annual avc. runoff = 22"/yr
See pg 19

$= (22''/yr \times 3.72\ Sq.mi \times 5280^2) \div (365 d/yr \times 24 h/d \times 3600 sec/hr)$

$= 6\ CFS$

Approx. avc. flow from Jug Brook

Total Q (Q... to impact area III :

$$\begin{array}{r} 1985\ CFS \\ -\ \ 6 \\ \hline 1979\ CFS \end{array}$$

checked by: [illegible]

West Hill Pond Dam

	H	L	Q
[illegible]	1	50	133
50'	.7	100	156
100	.4	100	67
137	.2	84	20

Σ increments = 376

+ Culvert 201

2085 CFS Before Dam Failure > 577 CFS

Try H over road at 1' above house sill = 1058.7
(this assumes road is not washed out)

Culvert:

$H_c = 6' + 1.2 - .7 + 1 = 7.5$

$$\left[\frac{7.5}{6} - 1 + \frac{.75}{6}\right] = \frac{8}{\pi^2 g}\left(1 + .5 + \frac{.0260\times 34}{6}\right)\left(\frac{Q}{6^{5/2}}\right)^2$$

$Q = 265\ CFS$

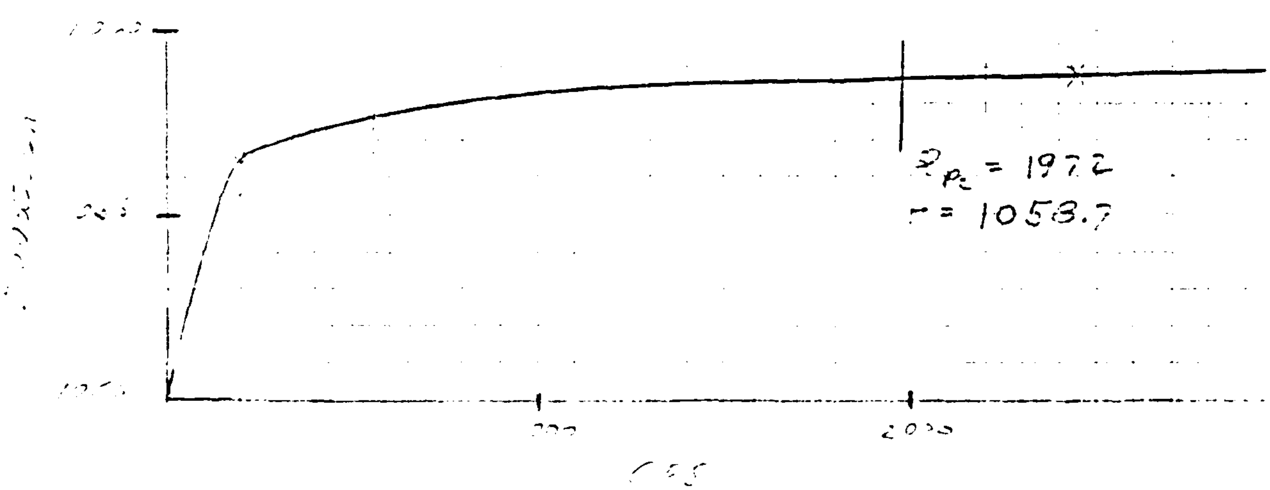
Flow over road

	H	L	Q
[illegible]	2.0	50	376
50	1.7	100	540
100	1.4	100	441
150	1.3	100	394
200	.8	100	190
250	.6	100	124
300	.3	100	44
350	.1	18	—

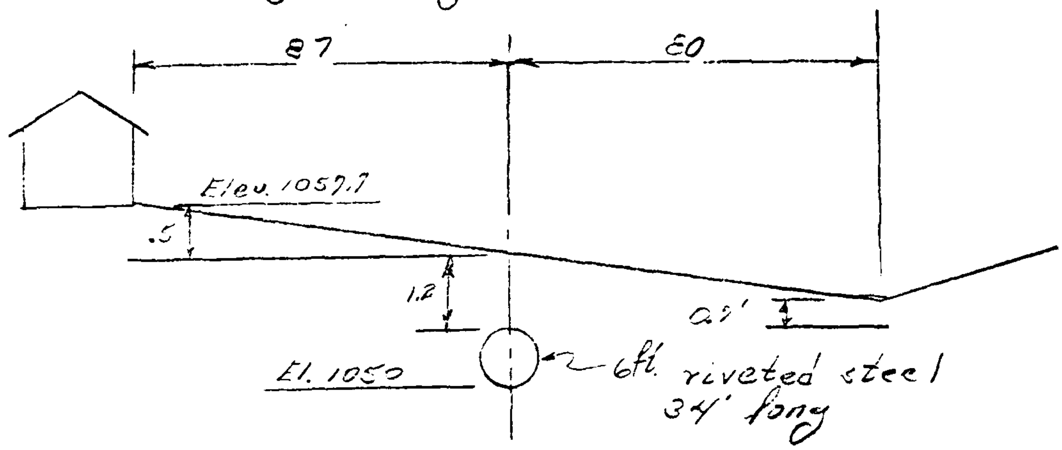
Σ increments = 2159

+ Culvert = 265

2424 CFS



n.d. II Road crossing at Joy Brook before confluence



Determine capacity of culvert with water at low point in road surface.

$H = 6' + 1.2' - 0.7' = 6.5' = \underline{1056.5}$
$D = 6', L = 34'$
$z = .75$
$k_e = .5$
$f = 185 \frac{.016^2}{6^{1/3}} = .02606$ where $n = .016$

$\therefore \left[\frac{6.5}{6} - 1 + \frac{.75}{6}\right] = \frac{8}{\pi^2 g}\left(1 + .5 + \frac{.02606 \times 34}{6}\right)\left(\frac{Q}{6^{5/2}}\right)^2$

Culvert Q = 198 CFS < 1961 CFS Before dam failure
[198 CFS > 37.7 CFS Spillway cap.]

Try H with water at sill of house, elev 1057.7

Flow over road

$Q = 3.06 \times L \times H^{3/2}$

select incremental L & H_{avg}, $H_p = 1$, $L = 50'$

11. d. III Impact area at road crossing above Jug Brook

$n = .04$
$S = .0027$
Reach $L = 4800$ ft

13 y | 10 y; 1 : 13; 1 : 10; y

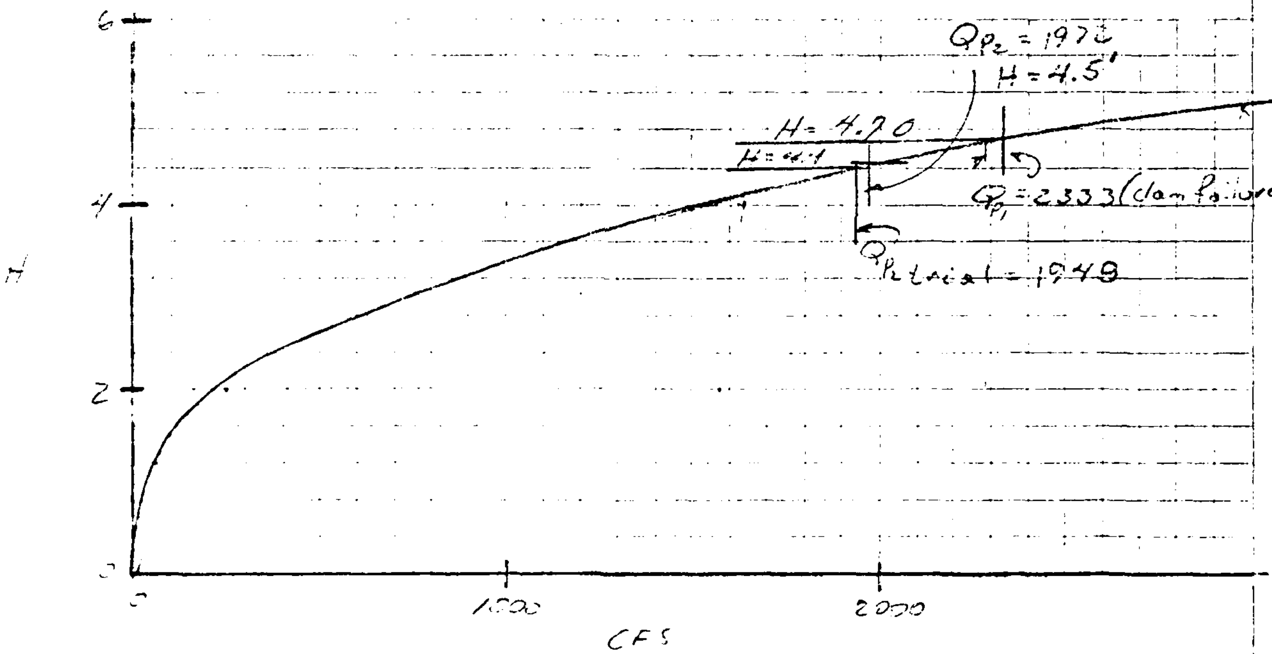
$Area = \frac{1}{2} \times 23 y^2 = 11.5 y^2$

Wetted Perim. $= [(1+13^2)^{\frac{1}{2}} + (1+10^2)^{\frac{1}{2}}] y$
$= 23.1 y$

y	WP	A	R	Q CFS
1	23.1	11.5	1/2	40
2	46.2	46	1	259
3	69.3	103.5	1.5	760
4	92.4	184	2	1638
5	115.5	287.5	2.5	2964

$Q = \frac{1.486}{n} \times A \times R^{2/3} \times S^{1/2}$

$= 5.597 \times A \cdot R^{2/3}$



$V_1 = 4800$ ft $\times (11.5 \times \overline{4.7}^2) \div 43,560 = 28$ Ac. Ft

Check $V_1 < \frac{1}{2}$ Res. storage $= \frac{1}{2} \times 170$ Ac. Ft

Q_{P_2} trial $= Q_{P_1}(1 - \frac{V}{S}) = 2333 (1 - \frac{28}{170}) = 1948$ CFS

$V_2 = 4800$ ft $\times 11.5 \times \overline{4.4}^2 \div 43,560 = 24.5$ Ac. Ft

$Q_{P_2} = 2333 (1 - \frac{(28+24.5)/2}{170}) = 1972$ CFS

Checked by [illegible] West Hill Pond Dam

II.C.I

@ H = 9.4, L = 10 ft, Q = 968

@ H = 8.3, L = 10 x 2, Q = 1280

@ H = 7.3, L = 10 x 2, Q = 1040

@ H = 6.2, L = 10 x 2, Q = 818

@ H = 5.1, L = 10 x 2, Q = 614

@ H = 4.0, L = 10 x 2, Q = 431

@ H = 3.0, L = 10 x 2, Q = 270

@ H = 1.9, L = 10 x 2, Q = 137

Σ 5358 CFS above culvert

1047 culvert

6405 CFS

@ H = 3.0 675 culvert

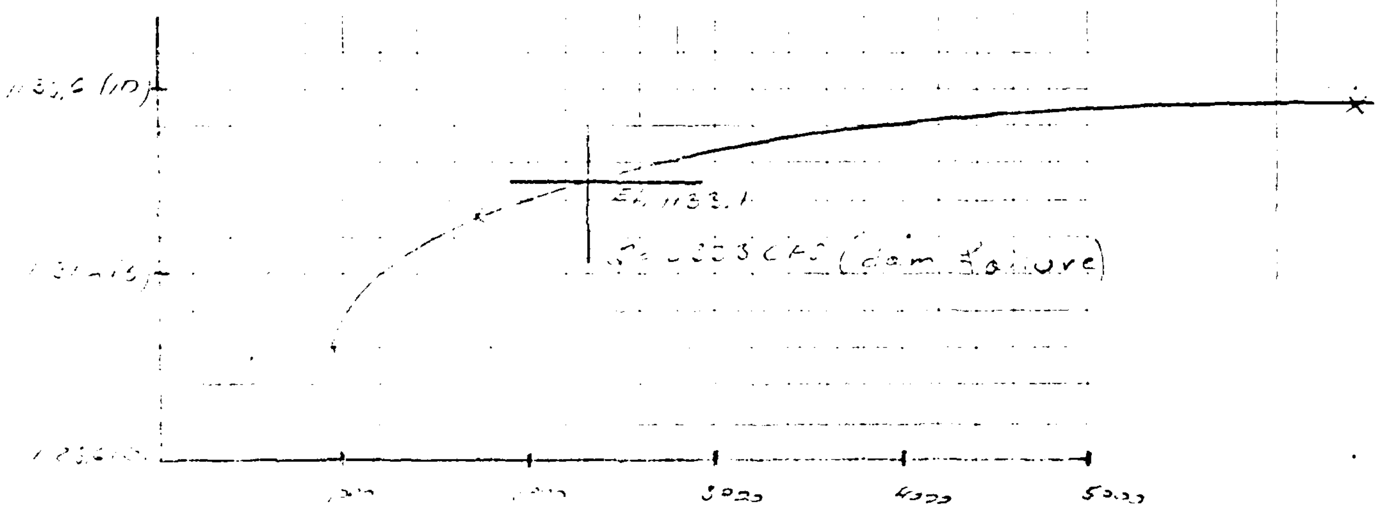
270/2 + 137 = 272

947 CFS

@ H = 6.57 818

884 culvert

1702 CFS



II.C.I

@ H = 4.78, L = 10x2, Q = 557

@ H = 4.07, L = 10x2, Q = 438

@ H = 3.37, L = 10x2, Q = 323

@ H = 2.6, L = 10x2, Q = 231

@ H = 1.9, L = 10x2, Q = 145

@ H = 1.2, L = 10x2, Q = 73

@ H = .53, L = 10x2, Q = 21

Σ increments = 2886

\+ 1047 Culvert

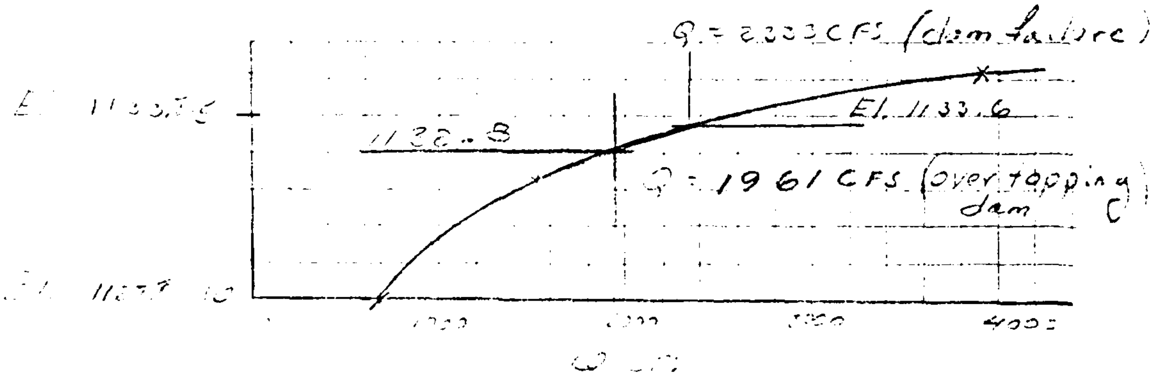
3933

Try H over road at 3.37, H culvert = 11.2 + 3.37 = 14.57

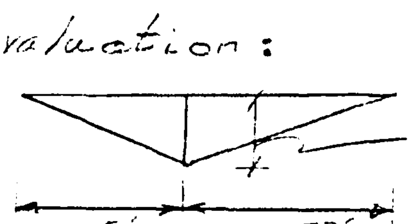
Q culvert = 884 CFS

Q road = 323/2 + 231 + 145 + 73 + 21 = 631 CFS

Σ = 1515 CFS



After dam failure evaluation:



1135
−(1117.6)
(+8)
9.4'

[illegible] same analysis as for before break

II.C.I

Determine capacity of culvert with water at road surface. Use "Hydraulics of Culverts" Am. Conc. Pipe Assoc. 1957

$$\left[\frac{H}{D} - 1 + \frac{Z}{L}\right] = \frac{8}{\pi^2 g}\left(1 + k_e + \frac{fL}{D}\right)\left(\frac{Q}{D^{5/2}}\right)^2$$

$H = 1128.8 - 1117.6 = 11.2$

$D = 8'$ $L = 68'$

$Z = 1.5'$ (vertical drop in culvert)

$k_e = .5$ (square edged inlet)

$f = 185 \frac{n^2}{D^{1/3}}$ $n = .015$ $= .0208$

$$\therefore \left[\frac{11.2}{8} - 1 + \frac{1.5}{8}\right] = \frac{8}{\pi^2 g}\left(1 + .5 + \frac{.0208 \times 68}{8}\right)\left(\frac{Q}{8^{5/2}}\right)^2$$

Culvert <u>Q = 615 CFS</u> < 1961 CFS Before dam failure

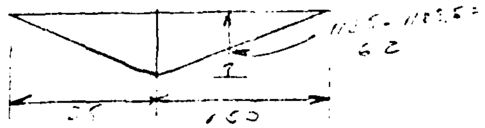
Try H with water at sill of house el 1135

$H = 1135 - 1117.2 = 17.8$

$$\therefore \left[\frac{17.8}{8} - 1 + \frac{1.5}{8}\right] = \frac{8}{\pi^2 g}\left(1 + .5 + \frac{.0208 \times 68}{8}\right)\left(\frac{Q}{8^{5/2}}\right)^2$$

Culvert Q = 1047 CFS

Now calc. flow over road:



$Q = .8 \cdot 3.00 \cdot L \times H^{3/2}$

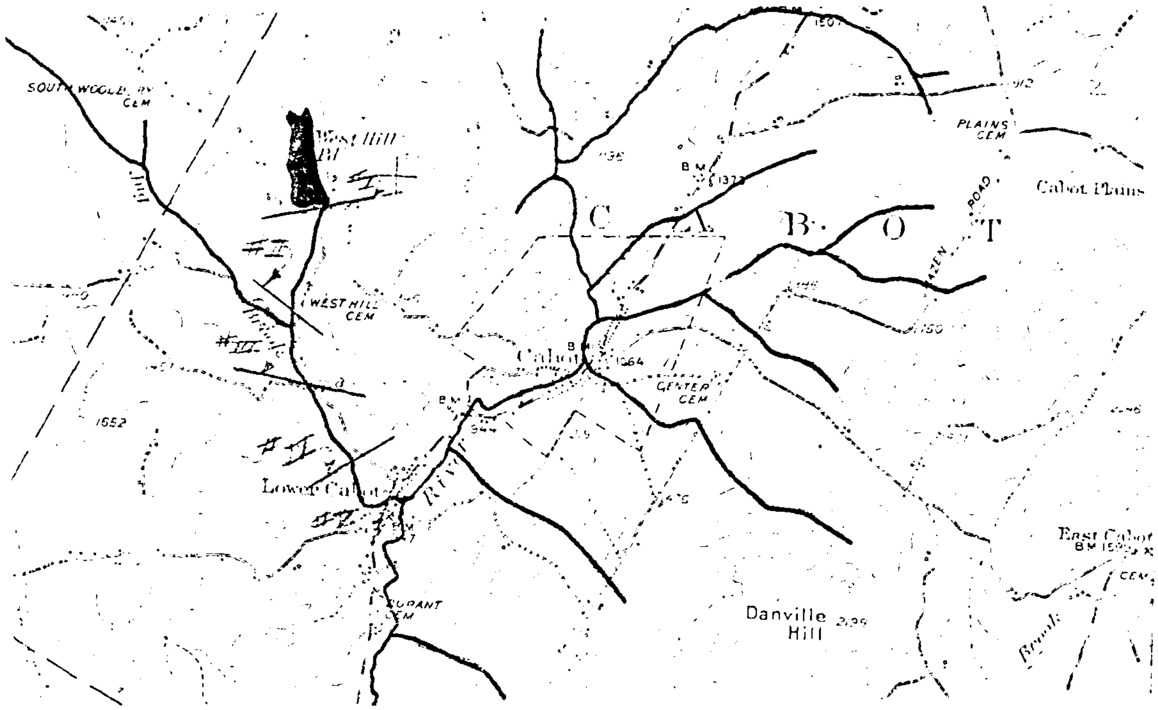
[illegible] triangular L & H H = 6.2', L = 10'

$Q = [illegible] \times 10 \times 6.2^{3/2} = 411$ CFS

[illegible] H = 3.5 L = 10' [illegible] increments

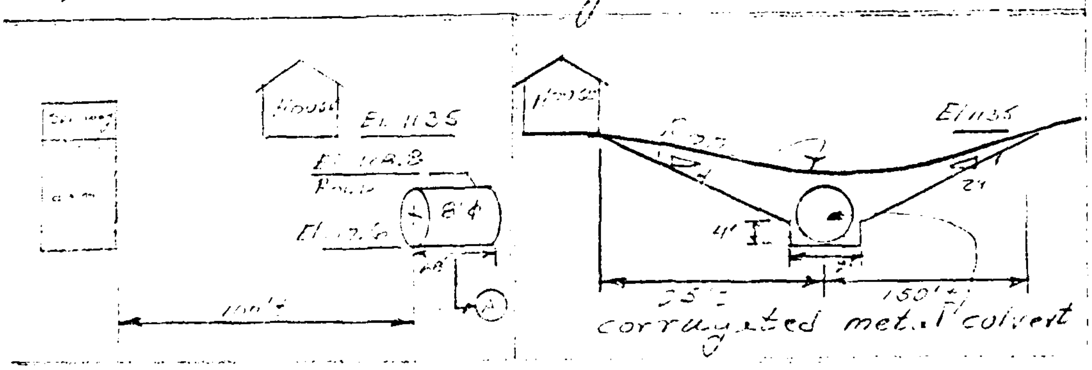
Q = [illegible] $^{3/2}$ = 687 CFS

c. Downstream channel conditions



Ref: USGS map Plainfield, Vt
Horz. 1" = 1 mile
Vertical contour interval = 20'

c.I Impact area immediately downstream of dam



Before dam failure assume road remains intact

After dam failure assume road lost to top culvert

Assume intact road acts as broad crested weir

checked by [illegible] West Hill Pond Dam

11. c I

$V_1 = 40 \times 3.05^2 \times 2100 \div 43{,}500 = 17.9$ Ac.Ft.

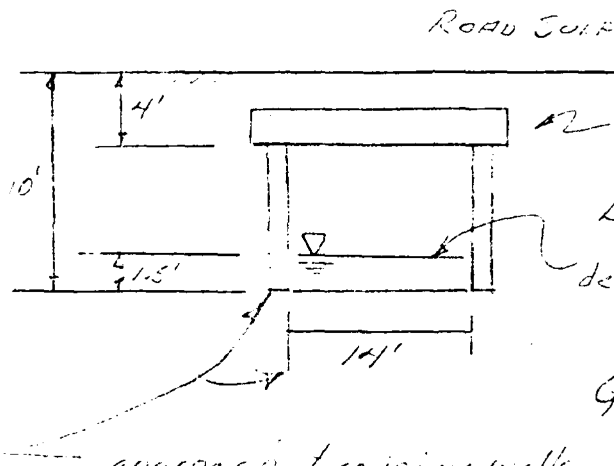
Q_{P_2} trial $= 1942\left(1 - \frac{17.9}{170}\right) = 1558$ CFS

$V_2 = 40 \times 2.9^2 \times 2100 \div 43{,}560 = 16.2$ Ac.Ft

$Q_{P_2} = 1942\left(1 - \frac{(17.9 + 16.2 \div 2)}{170}\right) = 1567$ CFS

$H = 2.9$ ft

For Culvert Crossing at Main St. & confluence of Winooski River



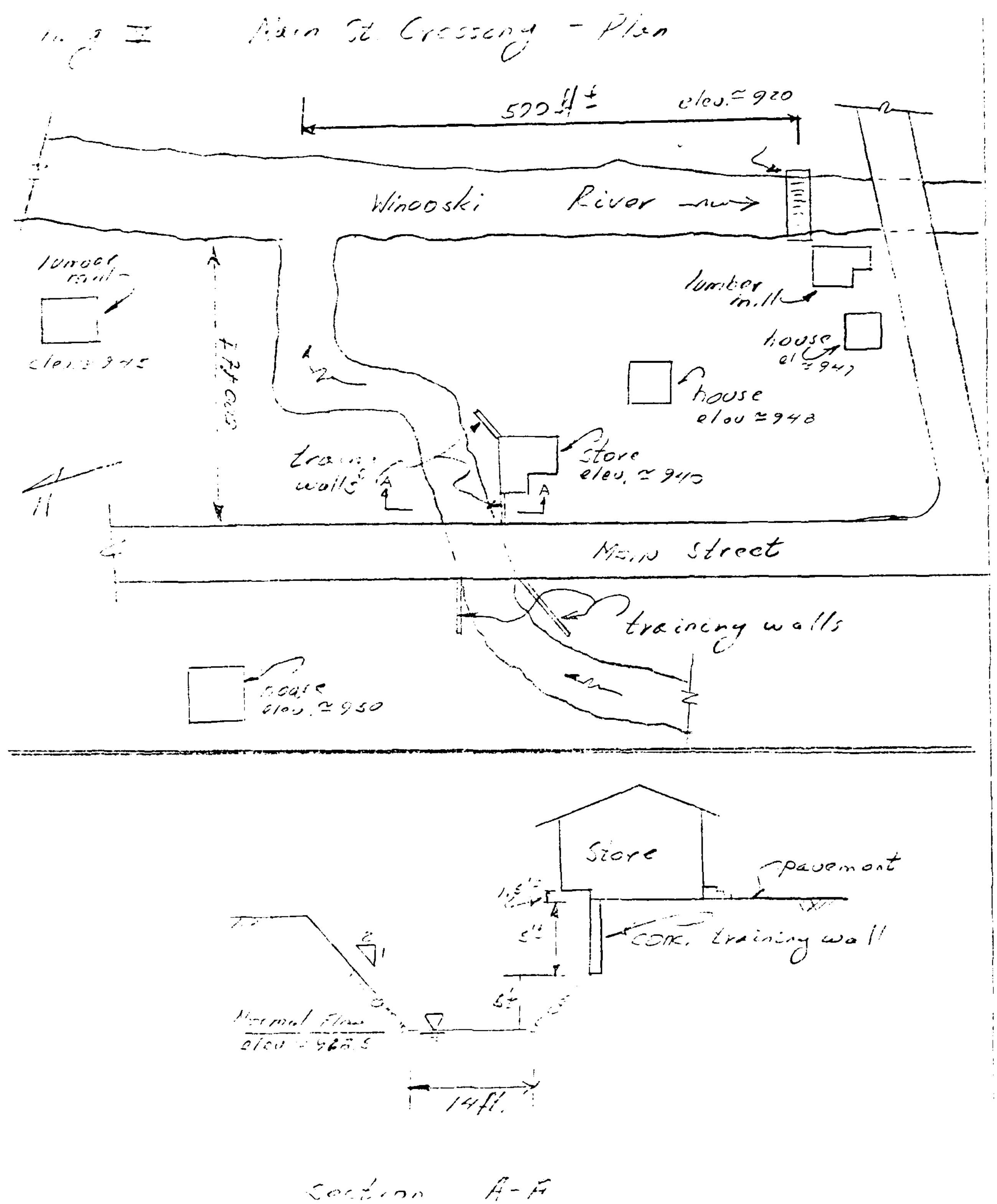
$Q_{normal} = \frac{1.486}{.014} \times 1.5 \times 14 \times \left(\frac{1.5 \times 14}{17}\right)^{2/3} \times .0095^{1/2}$

$Q_n = 250$ CFS see p. 18 for comparison

For box flow to just below roof:

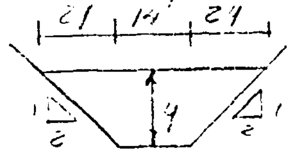
$Q = \frac{1.486}{.014} \times (6 \times 14) \times \left[\frac{6 \times 14}{[illegible]}\right]^{2/3} \times .0095^{1/2}$

$= 1890$ CFS > 1567 CFS after dam failure


Main St. Crossing - Plan
520 ft ±
elev. ≈ 920
Winooski River
lumber mill
elev. ≈ 945
lumber mill
house
el ≈ 947
house
elev. ≈ 948
store
elev. ≈ 940
training walls
A
A
Main Street
training walls
house
elev. ≈ 950
Store
pavement
conc. training wall
Normal Flow
14 ft.
Section A-A

11.g. II

down stream conditions at Main Street Crossing



$n = .025 \quad S = .02154$

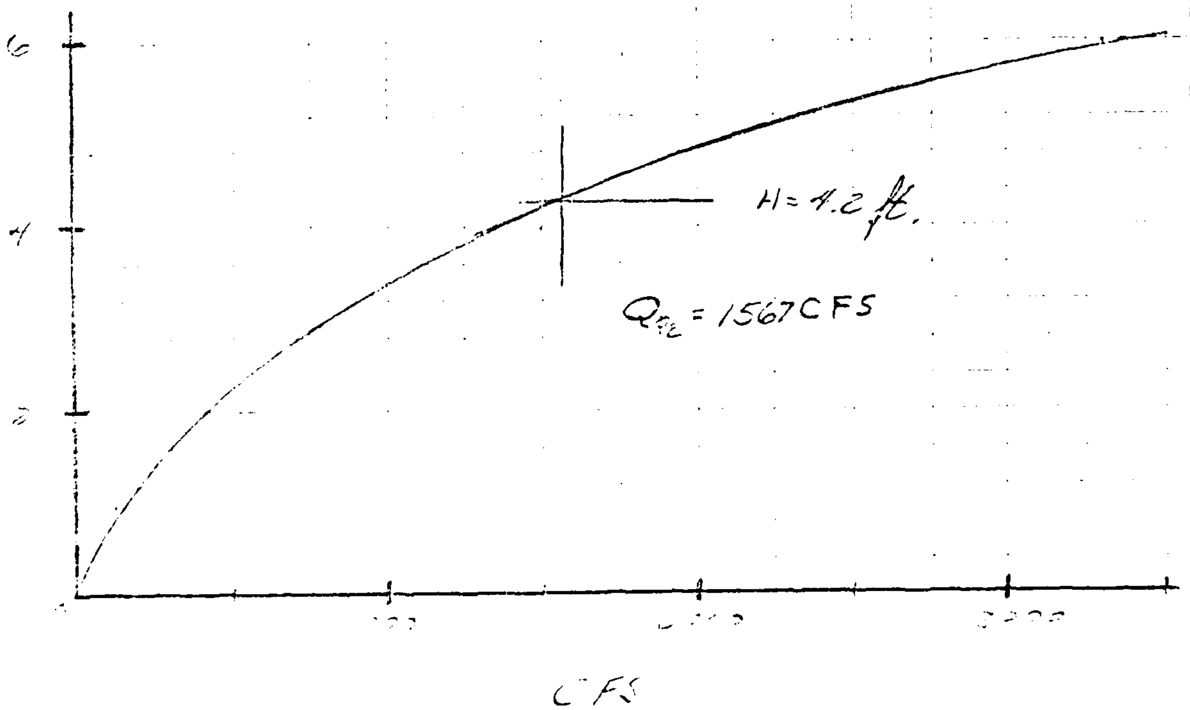
$Area = 14y + \frac{1}{2} \times 2 \times 2y^2 = 14y + 2y^2$

$WP = 14 + 2\sqrt{5}\,y$

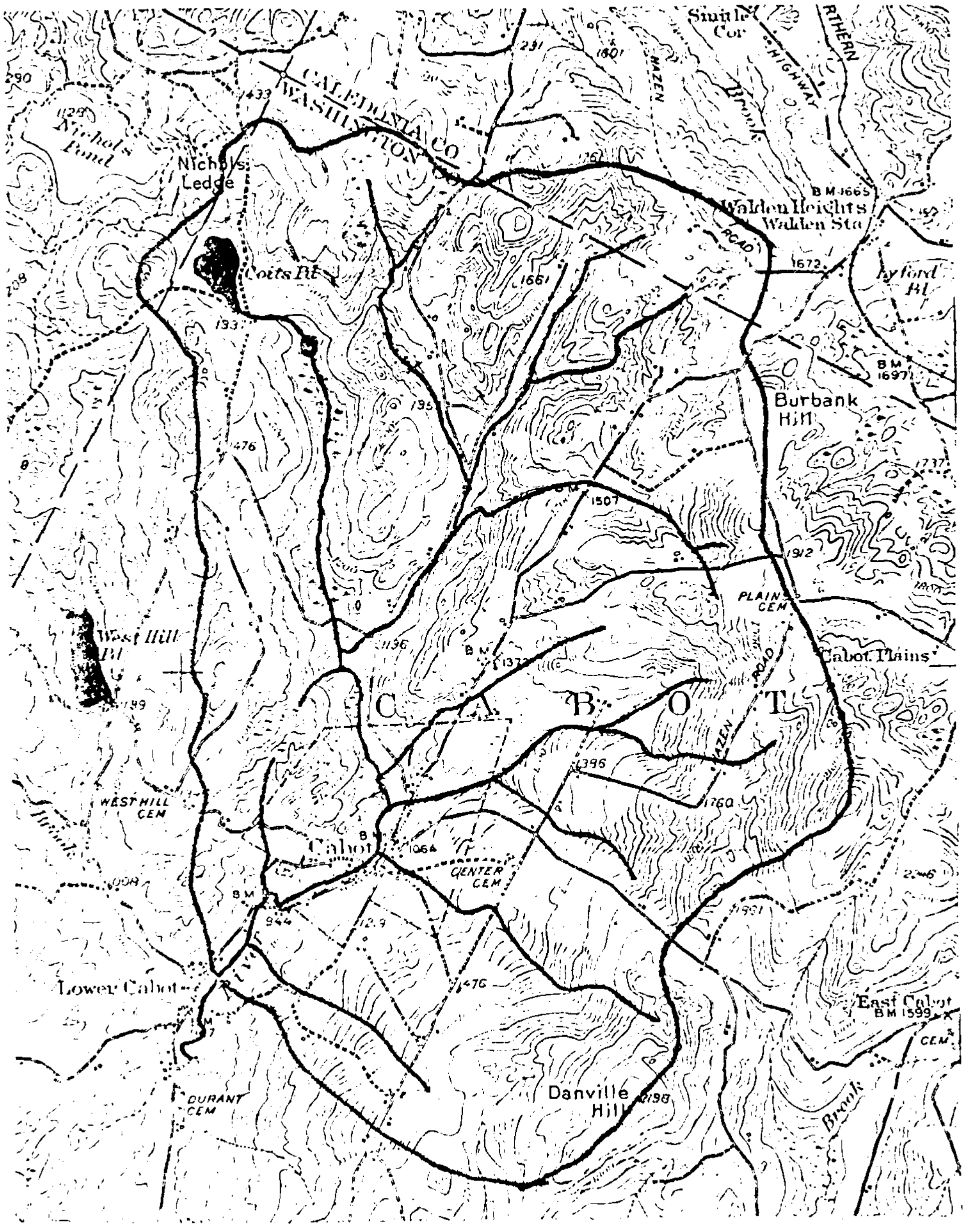
$Q = \frac{1.486}{.025} \cdot A \times R^{2/3} \times .02157^{1/2}$

$= 8.72\ A R^{2/3}$

y ft.	WP	A	R	Q CFS
1	18.5	16	.86	129
2	22.9	36	1.6	424
4	31.9	88	2.8	1509
6	40.8	156	3.8	3326



II.g.I Winooski River Drainage area

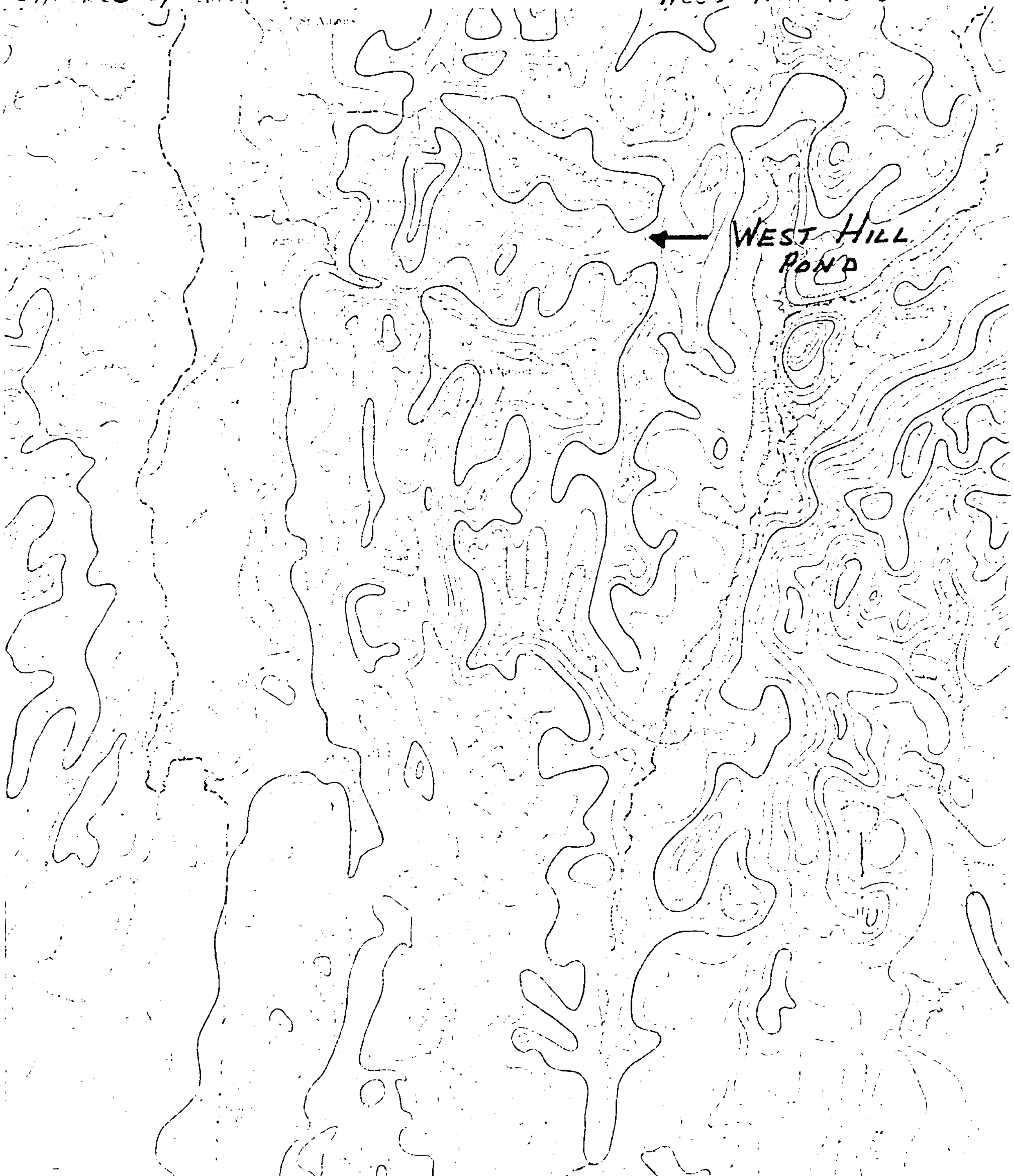


Estimated Peak discharge Winooski River

S = main channel slope = $\frac{1320-960}{17800} = .0202 \times 5280 = 107'/mi$

P = mean annual precipitation = 40 in = 3.33 ft
(see pg 29)

Calculations using "Flood Magnitude & Frequency of Vermont Streams" Johnson & Tasker March 1974 [illegible] similar to western Massachusetts



MAP SHOWING AVERAGE ANNUAL PRECIPITATION

IN THE

NEW ENGLAND-NEW YORK AREA

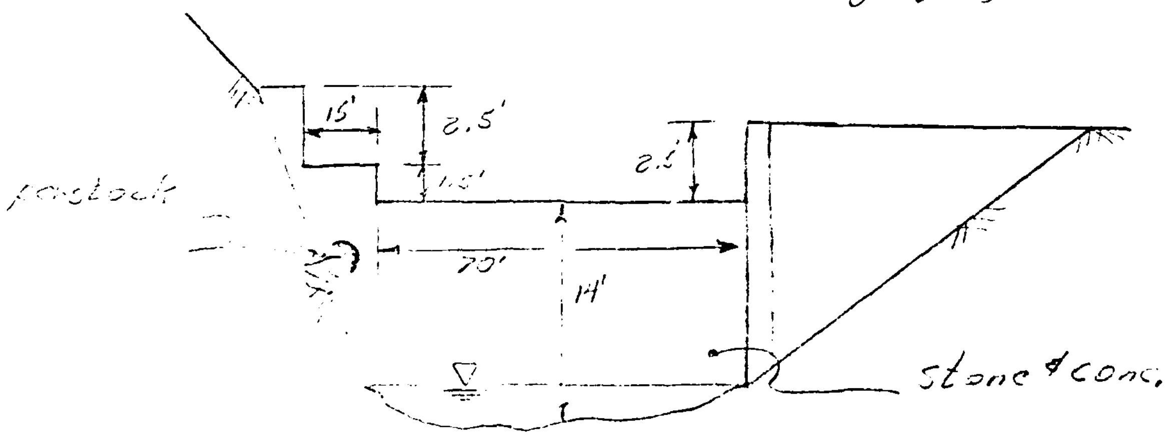
11.g Effect on Winooski River

drainage area = 15.5 Sq. Mi (see pg 28)
annual ave. rainfall = 3.33 ft
main channel slope = 107 ft/mi

Frequency	C	A	15.5^{A}	S	107^{S}	P	3.33^{-P}	Q CFS
2	.0645	.816	9.36	.091	1.53	4.59	250	230
5	.0795	.831	9.75	.116	1.72	4.67	275	369
50	.193	.911	12.14	.171	2.22	4.27	170	885
100	.260	.940	13.15	.187	2.40	4.08	135	1110

with dam failure Q = 1567 CFS
effect on Winooski River is greater
than Winooski 100 yr. flood.

h. Effect on dam located downstream of
confluence on Winooski River (11g pg 26)



Downstream face of Winooski River
... ...

11.h spillway capacity

$$Q = 2.66 L H^{3/2}$$
$$= 2.66 \times 70' \times \overline{2.5}^{3/2} + 2.66 \times 15 \times \overline{7}^{3/2}$$
$$= 776 \text{ CFS} \quad \text{dam topping } Q$$

Q to dam:

assume Winooski River at Ave. flow

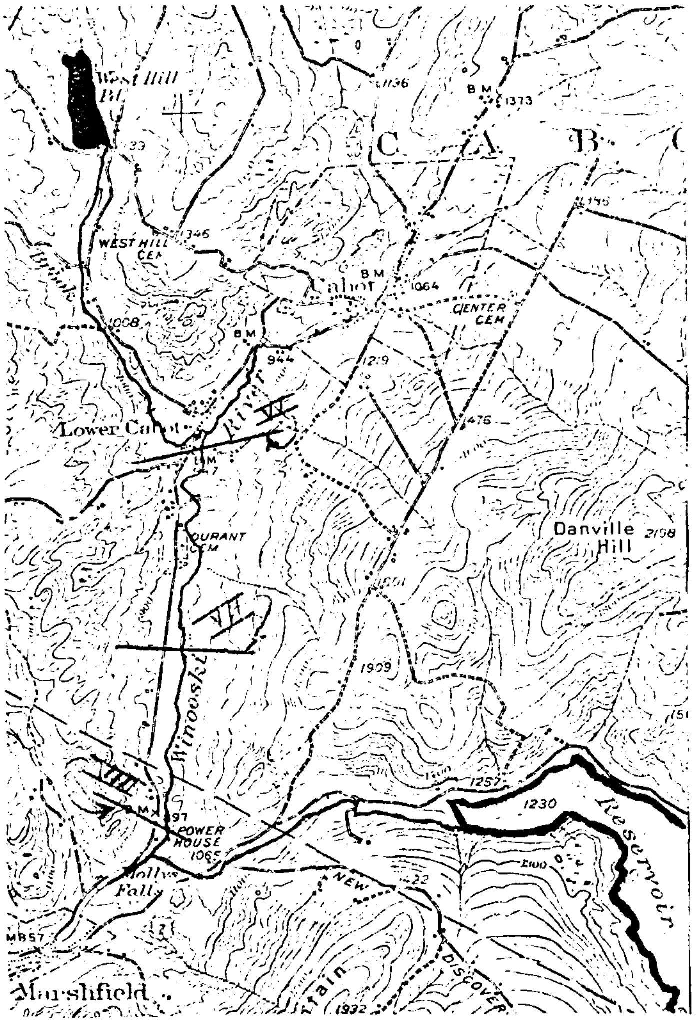
$$= (22''/yr \times 15.5 \text{ Sq. Mi} \times 5280) \div (365 d/yr \times 24 hr/d \times 3600 s/hr)$$
$$= 25 \text{ CFS}$$

+ flow from West Hill Pond Dam = 1567 CFS (11g)

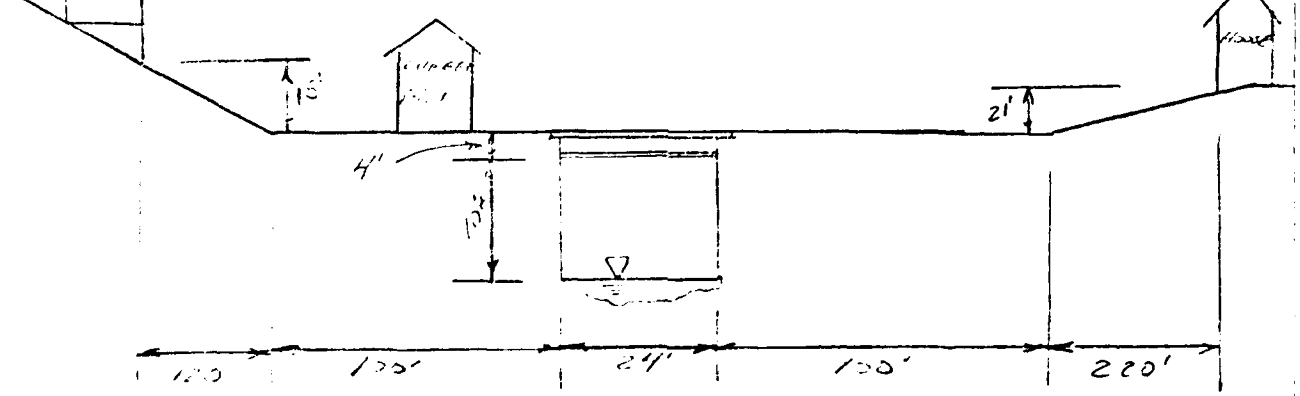
$\Sigma = 25 + 1567 = 1592 \text{ CFS} > 776 \text{ CFS}$

Assume Winooski River Dam overtopped but does not fail.

12. Downstream conditions below Winooski Dam



a. VI. Impact area immediately downstream of dam at road crossing ± 300



K. a. VI Bridge Q (just below bridge beam h=10')

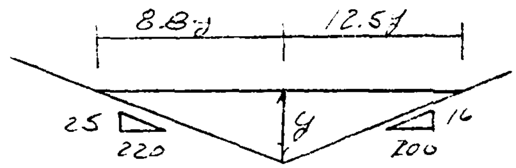
$S = .00291 \quad n = .015$

$$Q = \frac{1.486}{.015} \times 10 \times 24 \times \left(\frac{10\times 24}{2\times 10 + 24}\right)^{2/3} \times .00291^{1/2}$$

$Q_{max} = 3974$ CFS > 1592 CFS ok

b VII Impact area between Village of Lower Cabot and Cabot Hydro Elec Power Station

Reach $L = 5200$ ft $\quad n = .04, \; S = .00291$



Area = $\frac{1}{2} \times 21.3 y^2 = 10.7y^2$

Wetted Parameter =

$$\left[(1^2 + 8.8^2)^{1/2} + (1^2 + 12.5^2)^{1/2}\right] y$$

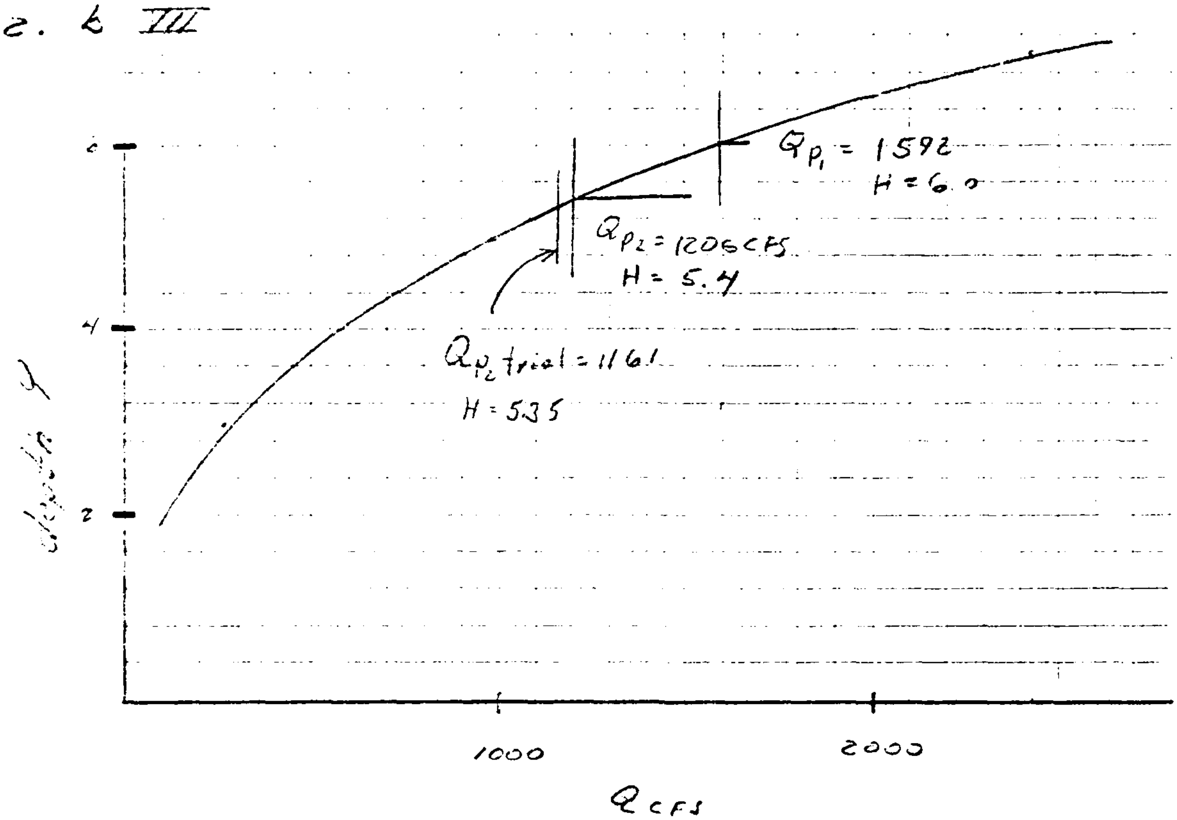
$= 21.4y$

$$Q = \frac{1.486}{.04} \times A \times R^{2/3} \times .00291^{1/2}$$

$= 2 \times A \times R^{2/3}$

y	WP	A	R	Q cfs
1	21.4	10.7	1/2	13.5
3	64.2	96.3	1.5	253
5	107	268	2.5	988
7	150	524	3.5	2427
9	193	867	4.5	4748

12. b III



$$V_1 = (5200 \times 10.7 \times 6.0^2) \div 43{,}560 = 46 \text{ Ac.ft.}$$

$$Q_{p_2\,trial} = 1592\left(1 - \frac{46}{110}\right) = 1161 \text{ CFS}$$

$$V_2 = (5200 \times 5.35^2 \times 10.7) \div 43{,}560 = 36.5$$

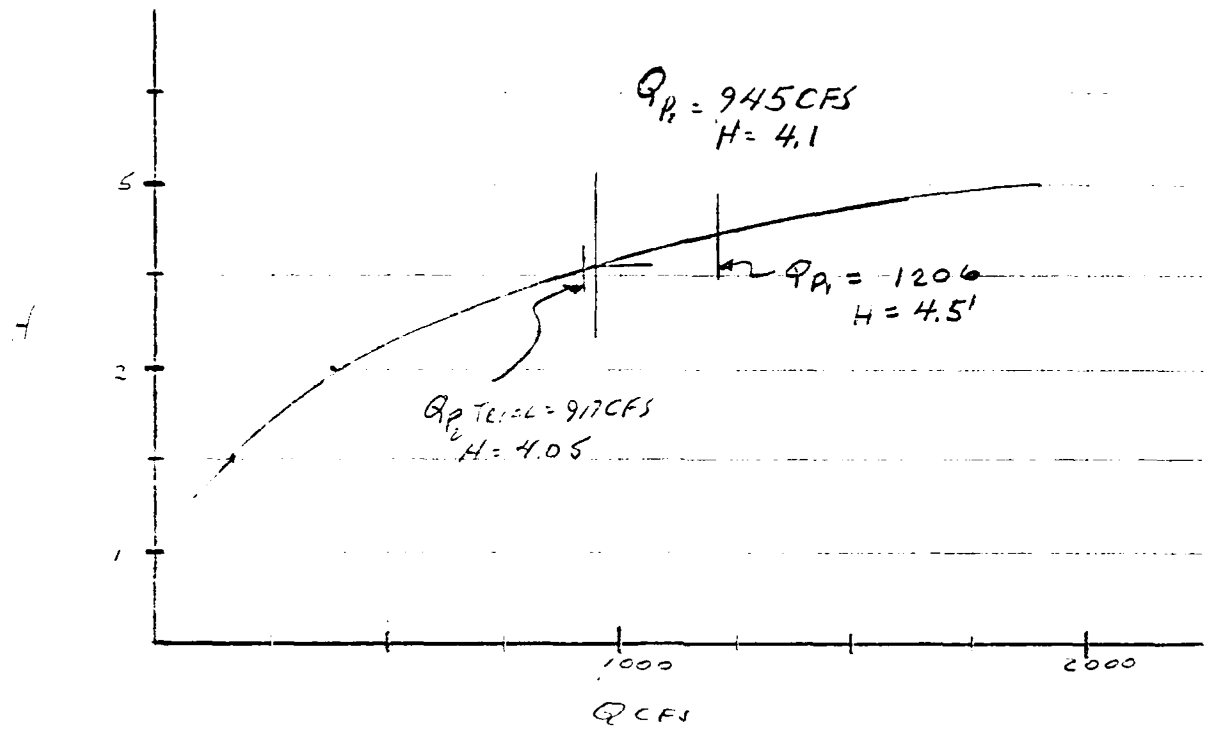
$$Q_{p_2} = 1592\left(1 - \frac{(36.5 + 46) \div 2}{110}\right) = 1206 \text{ CFS}$$

12. c III Impact area at Cabot Hydro Elec. Sta

n = .04 | Area = [illegible]
S = .004 | WP = [illegible]
Reach 5000 ft | $Q = \frac{1.493}{.04} \times AR^{2/3} \times .004^{1/2} = 2.34\ AR^{2/3}$

Y	WP	A	R	Q
2	[illegible]	70	1	164
3	105	158	1.5	432
4	[illegible]	280	2	[illegible]
5	175	438	2.5	1394
6	210	[illegible]	3	3018

2.C VIII



$V_1 = (5000 \times 17.5 \times 4.5^2) \div 43{,}560 = 40.7$

$Q_{P_2\,Trial} = 1206\left(1 - \frac{40.7}{170}\right) = 917$ CFS

$V_2 = (5000 \times 17.5 \times 4.05^2 \div 43{,}560 = 32.9$

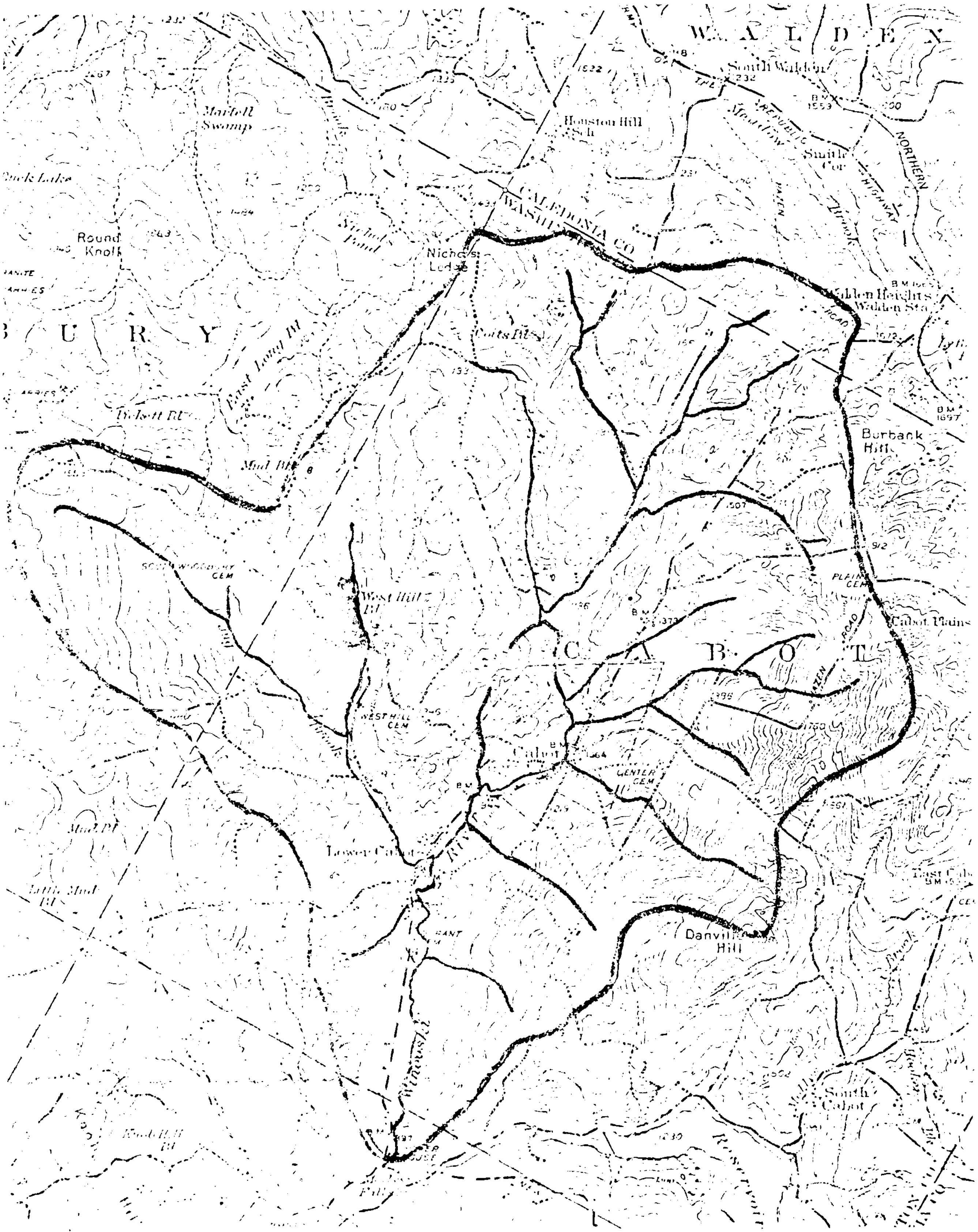
$Q_{P_2} = 1206\left(1 - \frac{(40.7 + 32.9) \div 2}{170}\right) = 945$ CFS

Impact at Cabot Hydro Elec. Sta; Check impact of 25yr storm on Winooski River see pg 36

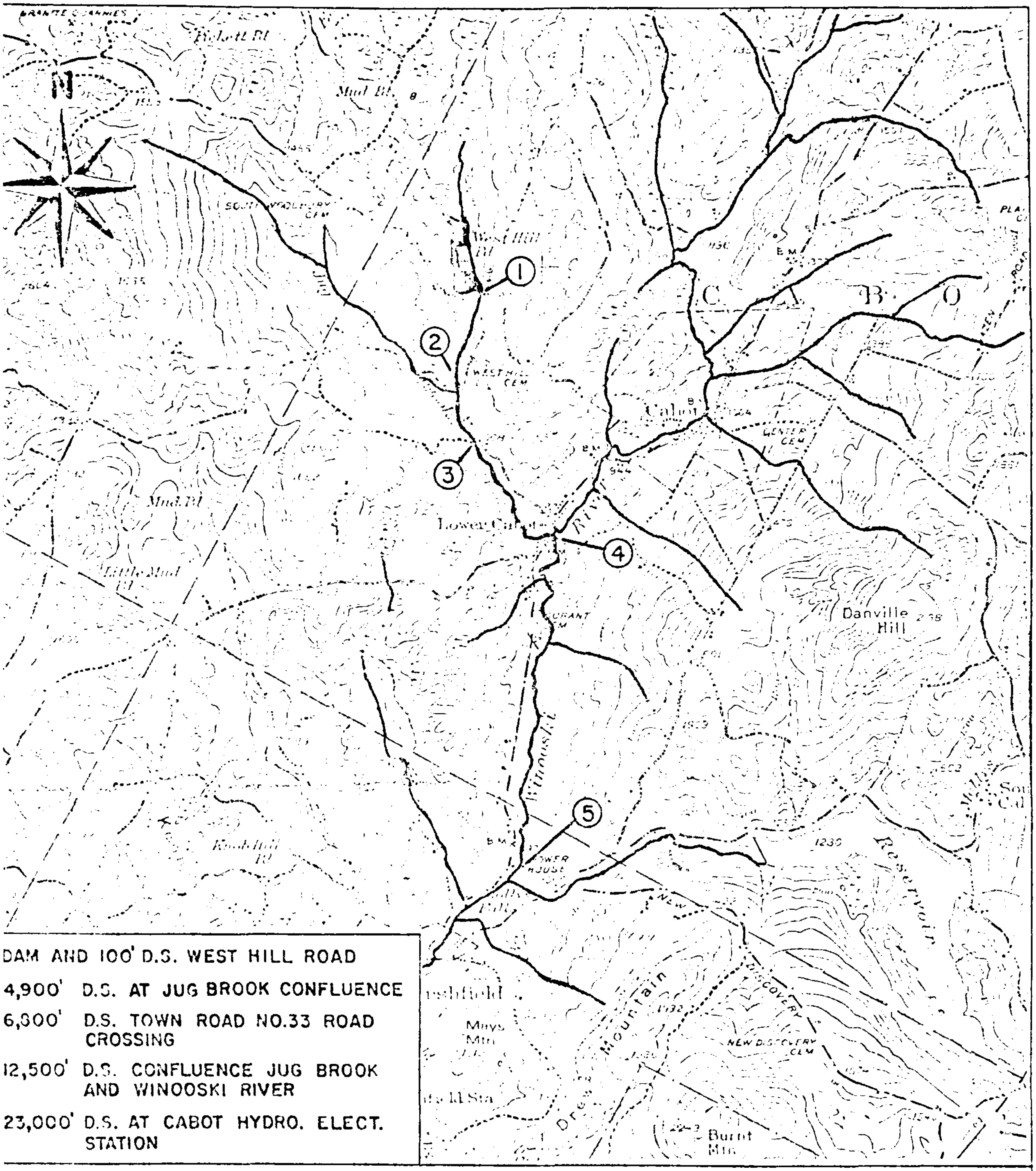
drainage area = 25.25 sq. Mi, annual ave rainfall = 3.33 ft, main channel slope = 73 ft/mi, $Q_{25} = (.144)(25.25^{.925})(73^{.155})(3.33^{.473})$

Q_{25} = 1003 CFS Therefore conclude impact of West Hill Pond is are roughly equivalent to 25 yr storm at Cabot Station, no damage at station is assumed.

West Hill Pond Dam



D-3



- SCALE -

0' 0 3000' 6000'

OM: USGS PLAINFIELD, VT. QUADRANGLE MAPS

TIGHE & BOND / SCI CONSULTING ENGINEERS EASTHAMPTON, MASS.	U.S. ARMY ENGINEER DIV. NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LOCATION AND DOWNSTREAM HAZARD MAP

WEST HILL POND DAM (VT. 00083) — CABOT
WASHINGTON COUNTY — VERMONT

SCALE: AS NOTED

DATE: JUNE 1980

APPENDIX E

INFORMATION AS CONTAINED IN THE
NATIONAL INVENTORY OF DAMS

END